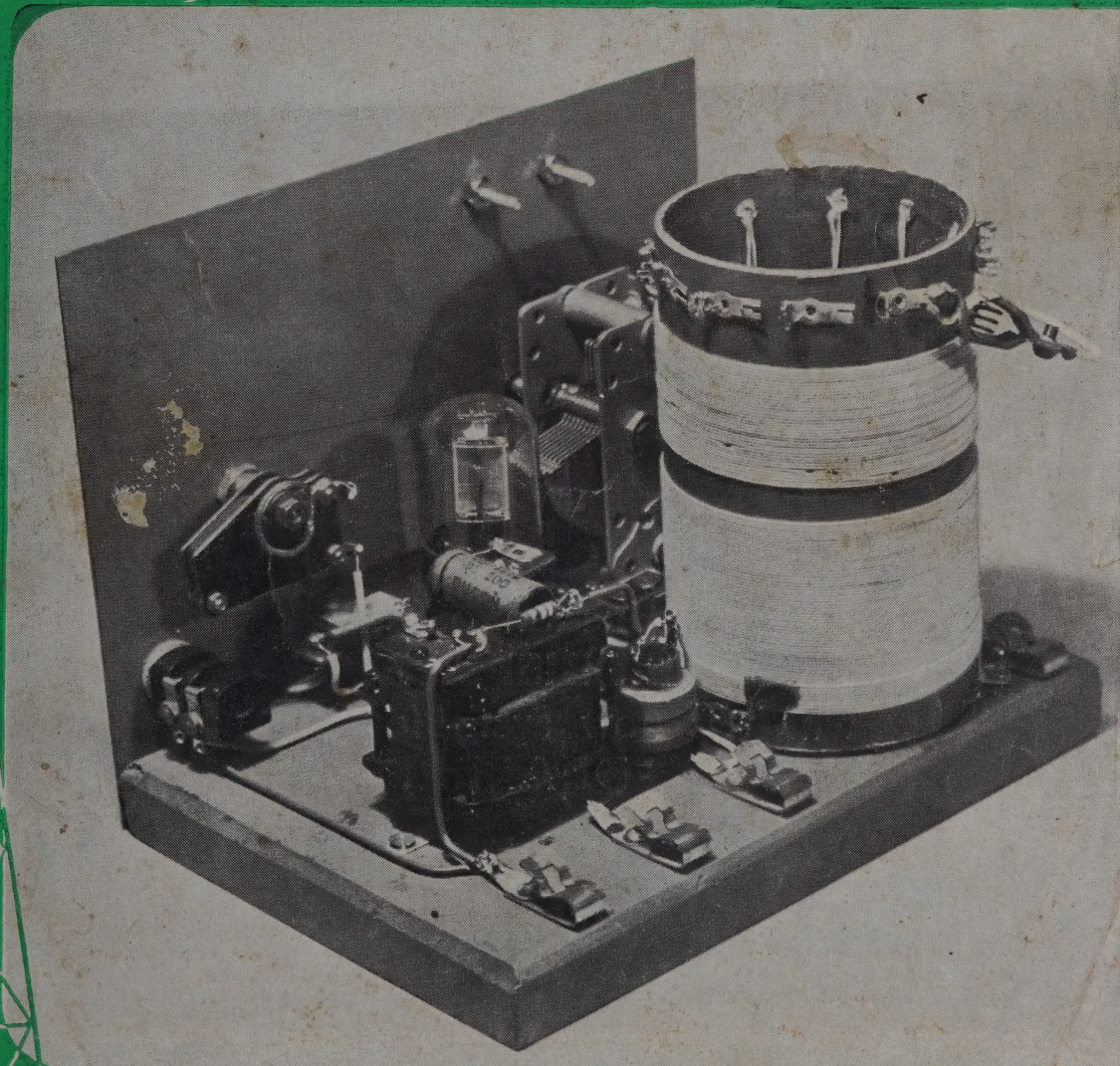
RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND



DECEMBER 1, 1948 VOL. 3, NO. 9

A SWAN PRODUCT

This Advertisement

is a reproduction of a
COUNTER DISPLAY
which is now available
to **ALL DEALERS**

Swan Electric Co. Ltd.

AUCKLAND · WELLINGTON · CHRISTCHURCH · DUNEDIN

RADIO and ELECTRONICS

Vol. 3, No. 9 1st December, 1948

Contents Page

EDITORIAL: CHRISTMAS GREETINGS 2

ADDING A SIGNAL-STRENGTH METER TO A COMMUNICATIONS RECEIVER 4

A PRACTICAL BEGINNERS' COURSE: PART 27 8

THE RADEL SINGLE-TWIN 12

A FIVE-INCH OSCILLOSCOPE EMPLOYING UNIT CONSTRUCTION: Part 2 17

TUBE DATA: Silicon Crystal Rectifiers Type CS 21

THE "RADIO AND ELECTRONICS" ABSTRACT SERVICE 33

OUR GOSSIP COLUMN 37

CLASSIFIED ADVERTISEMENTS 38

TRADE WINDS 40

THE PHILIPS EXPERIMENTER: No. 13: A Personal Portable Using the D90 Series of Valves 41

NEW PRODUCTS: Latest Releases in Electronic Equipment 45

OUR COVER:

This month's cover illustrates the Radel Single-Twin — a single-valve broadcast receiver specially designed for beginners and others who need a small set for the bedside which will not wake the neighbours or the children in the next room. A full description of this set is to be found on page 12 and succeeding pages of this issue.

CORRESPONDENCE

All correspondence, contributions, and enquiries referring to advertising space and rates should be addressed to:—

The Editor,
"Radio and Electronics,"
Box 22,
Government Buildings P.O
WELLINGTON.

●

OFFICES AND LABORATORY:
Radio and Electronics (N.Z.) Ltd.,
46 Mercer Street, Wellington.
TELEPHONE:
Wellington 44-919.

●

AUCKLAND REPRESENTATIVE:
Mr. J. Kirk,
No. 11 Keans Building,
150 Queen St., Auckland.
Telephone 48-113. P.O. Box 401.
AUSTRALIAN DISTRIBUTORS:
Messrs. Gordon & Gotch (A/sia.) Ltd.

●

Remittances from Australia to New Zealand should be by international money orders or bank draft payable in New Zealand.

Sole Wholesale N.Z. Distributors FEATURE PRODUCTIONS LTD., P.O. Box 5065, Wellington.

Printed in New Zealand by H. H. Tombs, Ltd., Wingfield Street, Wellington.

GUY E. MILNE
ELECTRONIC TECHNICIAN

Christmas Greetings

From . . . .

RADIO and ELECTRONICS
The Editor and Staff of *Radio and Electronics* wish all readers the Compliments of the Season, and all success in the coming year.
1/10

THE N.Z. RADIO MANUFACTURERS' FEDERATION

WM. J. BLACKWELL, M.Brit.I.R.E.

Radio is now so much a part of modern life—programmes on both broadcast and short-wave bands are continually improving in variety and scope—that more than one radio in the home is essential.

By keeping abreast with modern technical developments and production methods, New Zealand radio manufacturers ensure that the public always have available to them modern, up-to-date radio receivers in a remarkable variety of types and range of prices.

In wishing the Radio Trade and all associated with it a Joyous Christmas and a Happy and Prosperous New Year, the New Zealand Radio Manufacturers' Federation hand to the Trade as their slogan for 1949—"A Radio in Every Room—a Radio for Everyone!"

THE NEW ZEALAND RADIO TRADERS' FEDERATION

G. J. MARKBY, President.

As 1948 draws to a close the age-old season of goodwill and remembrance is once again upon us.

The Festive Season teaches us the lesson of Peace and Goodwill to all—a lesson we should bear in mind the whole year round.

But let us say goodbye to 1948 without misgivings and turn to the future with renewed determination to make the best of what opportunity offers. Let everyone work with a real purpose and aim, courageously striving to hold the banner of the Radio Trade high on the road to more settled times that must assuredly lie ahead.

We must have unity throughout the Trade, so may we all make a New Year resolution to be united in our activities, and in order that we may all be united, let us all personally resolve to have every Radio Trader a member of the Federation.

If we make unity our aim for 1949 and let more of the quiet Christmas approach enter our business relationships, I am confident that our difficulties will not prove insurmountable.

In conclusion, may I wish all members of the Federation and my friends in the trade a Bright and Happy Christmas and a Prosperous New Year.

G. J. MARKBY,
President.

THE "RADIO AND ELECTRONICS" PORTABLE COMPETITION

We take this opportunity of thanking all those who submitted entries for the above competition. The prize-winners will be announced in the January issue of *Radio and Electronics,* and in that issue also will be published the two designs that win first and second prizes. The January issue will be on sale before Christmas, and the prize-winners will have their prizes available for them before Christmas also, but at the earliest possible date.

We would like, too, to thank the advertisers who made the impressive list of prizes possible, and to wish one and all who have helped to make the competition a success, a special Christmas greeting of their own. Long may their interest as amateurs in radio continue.

THE EDITOR.

EXELRAD

rings the bell again

With completely redesigned Power Transformers, Chokes, and Audio Transformers. Conservatively designed—will always deliver their rated output under any conditions—all carefully impregnated and are guaranteed for twelve months.

Manufactured and distributed by:

TURNBULL & JONES LTD.

Auckland, Wellington, Christchurch, Dunedin, Hamilton, Palmerston North, Invercargill.

Adding a Signal-strength Meter to a Communications Receiver

We have often received requests to tell readers how to fit an S-meter to their particular type of receiver. Under most conditions it is possible to use one circuit, irrespective of the meter or type of receiver, only the values of resistors having to be altered to suit individual cases. This article describes a good circuit, and shows how the values can be estimated for any suitable receiver. A circuit is also given for adding an S-meter to any receiver that is not suitable for the main circuit.

Introductory

In the literature there are to be found numerous examples of receivers whose circuits include a signal-strength meter. We refer, of course, not to the magic eye, which is merely a tuning indicator, but to circuits which give an indication on a meter. Unfortunately the circuits and receivers concerned give specific values in the S-meter that apply only to the receiver with which the meter is included. There seems to be a complete dearth of information on how to design an S-meter circuit that will suit any particular receiver. With this in mind, we present this article. A particular circuit is recommended, because this has been found to give satisfactory results, and also because there is no need at all for the various types of circuit that are scattered through the periodicals. Of course there are receivers to which this circuit is not applicable, but these are comparatively rare, and in any case, to look after this contingency, a second circuit will be found in the latter part of this article—a circuit that can be added to any superhet. whatever with only one proviso: that it already has A.V.C.

Circuit Suitable for Most Receivers

The complete circuit is shown in Fig. 1. This shows V_1, V_2, and V_3, the valves in the receiver that are controlled by A.V.C. It does not matter how many, or how few, these stages may be, and we are not interested in anything but their cathode circuits. For this reason, Fig. 1 does not show any other parts of the circuit at all. It should be understood, of course, that the valves in whose cathode circuits the S-meter circuit is connected must be controlled by A.V.C., otherwise there is nothing which will operate the meter.

The principle on which the meter works is simply that as the signal strength varies, so does the A.V.C. voltage, and so also does the plate current in the valves that are controlled by the A.V.C. The meter itself merely measures the change in plate current of these valves, and the change is interpreted by the observer in terms of signal strength. It would be possible simply to connect a meter in the common plate supply lead to the A.V.C.-controlled stages. In this case, the meter would read the total plate current of the controlled stages, which is a maximum when there is no signal input. Then, when a signal came along, the total plate current would drop, causing a drop in the meter reading that is in some way proportional to the signal strength. This scheme has several disadvantages. In the first place, the change in plate current for a weak signal is very small, while the total plate current may be anywhere between 10 and 40 ma., so that the indication from weak signals is not at all sensitive. Secondly, the meter reads backwards, which though not affecting the operation at all, is not very desirable. The arrangement is sometimes found in commercial receivers, and is worthwhile remembering if it is desired to put a temporary indicator in circuit with the least possible disorganization to the set itself. If it is to be used as a permanent indicator, the way of arranging it is as follows. Suppose there are two controlled stages, each containing a 6K7; the sum of their plate currents will be, say, 16 ma. A 0-10 ma. meter is placed in series with the common plate supply lead, and is shunted by a low-resistance rheostat. Then, with no signal input, and with the manual gain control, if any, at maximum, the rheostat is adjusted until the meter reads full-scale. This is all there is to it, and if one wants the meter needle to move from right to left on indicating a signal, all one has to do is to mount the meter upside down.

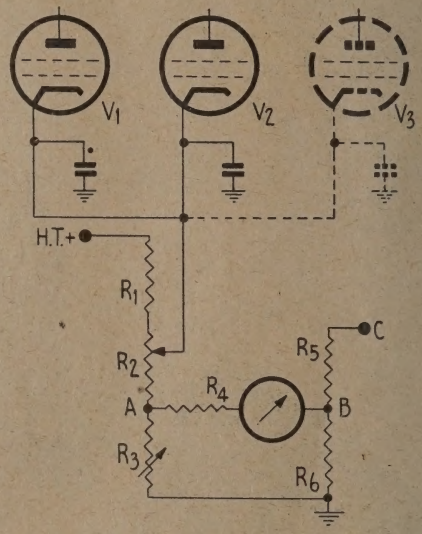


Fig. 1.

This system has been mentioned in passing, as it were, because it at least has the virtues of simplicity, and of not requiring a sensitive meter movement. However, to get back to Fig. 1. This may seem a little complicated at first sight, but in reality it is not so. To make matters a little clearer we have drawn Fig. 2, which shows the basic meter circuit. The object is to devise a circuit that will not only indicate signal strengths, but which reads forward in the usual manner of meters. Fig. 2 shows quite clearly that the meter itself is in a bridge circuit. If R_1 and R_2, regarded as a voltage divider, divide the potential applied to the bridge from earth to the point marked +, in the same ratio as do the resistors R_3 and R_4, then the points at the junctions of each pair will be at the same potential. It will therefore not be possible for the meter to read, since its terminals are at the same potential as surely as if it was not connected to anything at all. The condition just described, where the bridge is balanced, and no current can flow through the meter, is

that representing no signal into the receiver. Now, supposing that some change is made in the resistors making up the bridge. For example, suppose that R_1 is altered in value. This unbalances the bridge, and there is now a potential difference between the junctions of the two voltage dividers. The meter will therefore have a current passed through it, and it will read. This represents the presence of a signal in the receiver. Now let us see how the simplified circuit of Fig. 2 is related to the full circuit of Fig. 1.

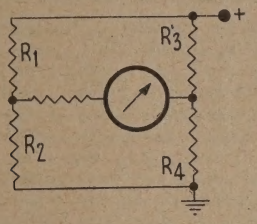


Fig. 2.

Here again we have the bridge circuit, with one or two simple modifications. First, R_5 and R_6 represent R_3 and R_4 respectively. Secondly, R_3, representing R_2 on Fig. 2, has been made variable. Finally, R_1 and R_2 in series deputize for the original R_1. R_4, the series resistor for the meter, can be ignored, as it plays no fundamental part in the operation of the circuit. It will be noted that the left-hand chain of resistors is connected at the top end to H.T. plus. The point C has not been specified as to its point of attachment in the circuit, but we will explain this later, except to say that C is attached to a point of fixed potential—one that does not vary when the signal strength changes. R_2 is the manual gain control of the receiver. At maximum gain, its moving arm will be at the point A on the circuit. Under these conditions, there is a positive potential at the point A, and this is applied to the cathodes of the controlled valves. Thus, the resistors R_1, R_2, and R_3 must be so chosen that at maximum gain, the point A is at a positive potential equal to the minimum bias required by the valves. This will usually be + 3v. Also, the values will have to be such that when the control is at the upper end of R_2, there is about 40v. positive applied to the cathodes of the controlled stages. This requirement is dictated by the fact that R_2 has to act as the manual gain control, and not by any considerations connected with the meter circuit. Thus, two conditions have to be fulfilled if the valves are to operate correctly—the point A must be at 3v., and the top end of R_2 must be at 40v., irrespective of the number of controlled tubes or of their type. Now for the meter circuit. One side of the meter is attached through R_4 to the point A, and the other goes to B. Since C is a place of fixed potential, B also will have its potential determined, first by the potential of C and secondly by the dividing ratio of R_5 and R_6. Now if the two latter resistors are so proportioned that the potential of B is always 3 volts, then at maximum gain the bridge is balanced, and there is no reading on the meter. Now consider what happens when a signal operates the receiver's A.V.C. First of all the plate currents of all A.V.C.-controlled stages drops, and the stronger the signal, the more the drop in current is. This being the case, there is less current flowing through R_3 than at no signal, and so the potential of the point A falls. Thus, if the negative terminal of the meter has been connected to the A side of the bridge, the meter will read forward. The S-meter therefore works, and all we have to do now is to ensure that however strong the signal, the meter is not driven off the scale. This is the purpose of R_1—simply to limit the current through the meter to a safe value when the greatest signal is being received, or when the manual gain control is at minimum.

It should be pointed out that when the manual gain control is backed off, the effect on the controlled tubes is identical with that produced by A.V.C., namely, that their plate current is reduced. Hence the bridge is unbalanced, and the meter reads, just as when it is actuated by a signal. This feature is common to all S-meter circuits which rely on the change in plate current of the controlled tubes for their operation. It does not occur with the circuit to be described later, in which a separate valve is used to actuate the meter.

Working Out the Values

Having seen how the circuit works, the next point of interest is the manner in which the values of the resistors are arrived at. This is quite simple, and involves nothing more difficult than a knowledge of the currents drawn by the controlled stages, and the application of Ohm's Law.

First of all, let us assume as a basis for a worked example, that we have three controlled tubes, two of them 6K7's, and the third a 6K8. On looking up the valve manual, we find that under normal conditions the 6K7's draw 7.0 ma. plate current and 1.7 ma. screen current. This makes a total current for these two valves of 17.4 ma. when working with a minimum bias of 3v. The 6K8, we find, draws a total cathode current of 12.5 ma., so that the total current of the three valves is 29.9 ma.

Suppose further that the H.T. voltage of the set is 250. Then, without any special consideration, we decide

These books ARE NOW AVAILABLE! On our generous 10-day approval plan

Watson, Welch & Eby, Understanding Radio, 1946 ..... 20/6
Emery, Ultra High-frequency Radio Engineering, 1944 ..... 26/-
Simon, Radio Service—Service Trade Kinks, 1939 ..... 25/3
ARRL, The ARRL Antenna Book, 1947 4/6
Ware-Reed, Communication Circuits, 1947 ..... 30/-
Pierce, McKenzie & Woodward, M.I.T., Loran Long-range Navigation, 1948 51/-
Montgomery, Dicke & Purcell, M.I.T., Principles of Microwave Circuits, 1948 ..... 51/-
M.I.T. Radar School, Principles of Radar, 1946 ..... 35/-

NEW TITLES ON ORDER . . .

Walton, A.B.C. Electronics, 1947
Miller, Handbook Electronic Control, 1948 ..... 30/-
Brans, Radio Tube Mecum, 1947 ..... 21/-
Editors and Engineers, Antenna Manual, 1948 ..... 27/6

Write for our Radio and Electronics Book List

Technical Books Ltd

Phone 56-101 P.O. Box 318, Te Aro
11 Walter Street :: :: WELLINGTON

In a class of their own . . .

DALY ELECTROLYTIC CONDENSERS

When buying condensers—buy electrolytic condensers. . . . When buying electrolytic condensers—buy British-made DALY Electrolytic Condensers

Electrlytic condensers, while bearing a superficial resemblance to the paper-insulated type, are really far superior in manufacture and service. In the paper condenser the dielectric is waxed paper . . . while in the electrolytic condenser the dielectric is a thin layer of aluminium oxide (on the positive foil with D.C. types and on both foils with A.C. or "reversibles"). A further advantage of the electrolytic condenser is that the working cathode is of impregnated paper (the so-called cathode foil merely providing the necessary circuit).

Full information from

Russell Import Co. Ltd.

100 DIXON STREET - WELLINGTON
G.P.O. Box 102

ABEC

TRANSFORMERS for all purposes

POWER — AUDIO — OUTPUT either to standard or special specifications.

Oscilloscope Transformers

— as used in *R. and E.* Oscilloscope — are available from stock.

We are pleased to quote.

BRADLEY'S ELECTRICAL Co. Limited
57A Victoria Street, Wellington

"SNAPPY SNIPS"

TUBULAR COND. Solar, Sprague, Aerovox, From ZC1 spares. All tested at 1000v. for 5sec. 600v.: .01, 6d.; .02, 6d.; .05, 8d.; .1, 9d.; .25, 1/-.

ELECTROLYTIC COND. Solar, Aerovox, 25v. 25 mfd. 1/9

MAGIC-EYE HOLDERS. Socket, Cover, Resistor, Cable 4/6

VALVE SCREENS, Cadnium plated with bases 4½ in. x 1½ in. square ..... 9d.

ZC1 JACKS, with engraved name-plates: Key, 6d.; Mic & Line, 1/-; Double Dynamic Fone, 9d.

FONE PLUGS for above: Dynamic, 6d.; Standard, 1/-

DON'T HAVE LAZY METERS! Throw instantly into another circuit with a DPDT Meter Push Switch 1/11

HAVERSACKS for the **HOLIDAYS** 2/6

WAVE-CHANGE SWITCH: 2 pos., 9-pole, 3-bank 5/6

Mail your order with postage to

Sinewave Radio Co.

Mail Order. P.O. Box 53, Petone.

to make R_3 a wire-wound pot. of 25,000 ohms. It is obvious that R_3 will have quite a small value, and anyway, since the voltage across it will be only 3v., R_3 can be temporarily ignored, while we are fixing the value of R_1. We want a potential of 40v. at the junction of R_1 and R_2, when the gain control is at minimum. In this condition, the valves will be passing so small a plate current that the total cathode current can safely be ignored. Thus, if we make R_1 five times R_2, the voltage at their junction will be one-sixth of the H.T. voltage, or approximately 42 volts. R_1 is therefore chosen as 125k.

The next value to work out is that of R_3, and this needs a little care. Through R_3 we have flowing both the valve currents, and the bleed current through R_1 and R_2. The valve currents we already know to total 29.9 ma. The bleed current we can work out, knowing as we do that the H.T. voltage is 250, and that R_1 and R_2 total 150k. Thus, the bleed current will be

$$250 \times 1{,}000/150{,}000 = 250/150 = 1.66 \text{ ma.}$$

The total current through R_3 is therefore 31.6 ma. Now under conditions of maximum gain, we want three volts across R_3, so that from Ohm's Law we have: $R = 1{,}000E/I$ ohms, where I is in milliamps and E is in volts. Substituting the values we know, we get $R = 1{,}000 \times 3/31.6$. This works out to 95 ohms, so that since R_3 is to be adjustable, we decide to make it a 100-ohm rheostat. So far so good. We have fixed the values of R_1, R_2, and R_3 in such a way that the bias arrangements for the manually-controlled tubes are satisfactory. All we have left to do is to decide to what point on the circuit we will connect C, and to decide the values of R_5 and R_6. An obvious choice for the position of C is to connect it to H.T. +, but a little consideration rules this out. If the set, as most do, has a directly-heated rectifier valve, and C were connected to H.T., voltage would be applied to the R_5, R_6 branch of the bridge as soon as the rectifier heats up. This, however, is much sooner than the indirectly-heated valves warm up, with the result that until they do, the bridge is badly unbalanced, and a heavy current is passed through the meter. Since the positive terminal of the latter is connected to the point B, the effect of turning on the set is that the meter swings hard over past full-scale, and only returns when the indirectly-heated valves have warmed up. Thus, when the set has a directly-heated rectifier, it is not possible to connect C to H.T. without danger of damaging the meter. A simple way out of this difficulty is to connect C to the cathode of one of the non-controlled valves in the set. The logical choice is the output stage, as its cathode, when operating, is several volts more positive than is needed at B. Also, the current drawn by the output stage is large and constant, so that irrespective of the signal conditions, the point B always has the same voltage. Also, the output tube, being indirectly heated like the other valves in the set, warms up at about the same time as these. There is then no tendency for the meter to swing past full-scale while the set is warming up after turning on.

The easiest way of arranging R_5 and R_6 is to make them the cathode bias resistor for the output valve.

Continuing with our worked example, we will suppose that the output stage uses a 6V6. The bias resistor needed is therefore 250 ohms, so that $R_5 + R_6 = 250$ ohms. Now the bias voltage developed across these two resistors is 12.5v., but we need 3 volts at B, so that we have the further condition that $R_6/(R_5 + R_6) = 3/12.5$. But $(R_5 + R_6) = 250$ ohms, so that our last equation can be written: $R_6/250 = 3/12.5$ or $R_6 = 250 \times 3/12.5 = 60$ ohms. Now, since $R_5 + R_6 = 250$ ohms, R_5 must equal $250 - 60 = 190$ ohms.

Unfortunately, these values for R_5 and R_6 are non-standard, so we will have to see if we can alter them slightly, so as to use standard values, without upsetting either the output stage or the S-meter circuit. Suppose, then, that we make $R_6 = 50$ ohms, and $R_5 = 200$ ohms. In this case, there will obviously be no effect on the output valve, for its cathode resistor is still 250 ohms. But the voltage at B will be $12.5 \times 50/(50 + 200) = 2.5$v. This means that for the meter circuit to be balanced when there is no signal input, the point A will have to be at 2.5v. also. The controlled tubes will then have a minimum bias of only 2.5v. as against the three which they ought to have. If the set is stable with a minimum bias of 2.5v. on the controlled tubes, then no harm is done, and the above values can be settled upon. If not, there is another way out of the difficulty. R_5 can be fixed at 200 ohms, and R_6 can be made a 100-ohm rheostat. This makes both R_3 and R_6 variable, but both would be pre-set, and there is no difficulty about adjusting them. True, the output stage would finish up with very slightly more than 250 ohms for its bias resistor, but this will have a negligible effect on its performance.

Adjusting the Circuit

First of all, let us suppose that the exact values have been selected for R_5 and R_6. In this case the latter will not be adjustable, and the only pre-set control will be R_3. The procedure for setting up the meter circuit is then as follows. The circuit is completed by making R_4 equal to 5,000 ohms. This is a temporary value only, and serves to protect the meter while the adjustment is going on. The set is then turned on, and the manual control is set at maximum gain. Next, and before any adjustments are made, the aerial terminal of the set is earthed to the chassis, so as to minimize noise pick-up. After the set has quite warmed up, R_3 is adjusted so that the meter reads zero. Next, the set is put into normal operation, and the strongest local signals are tuned in. It is noted what the maximum meter reading is for the strongest signal that will be encountered in practice. Then, finally, the manual gain control is backed off to minimum, and a further note made of the maximum meter reading. If the manual control, as is likely, gives the greatest deflection on the meter, R_4 is then adjusted so that the meter just reads full-scale with the gain control at minimum. If, on the other hand, a signal should be found which produces more deflection than the gain control, R_4 should be adjusted with the set tuned to this signal, and the gain control at maximum. This done, any conditions of signal input or of gain control setting will not swing the meter past full-scale. The best meter to use is of course a 0-1 ma. meter, but it might be found that a 0-5 ma. one will do equally well. To see what sort of meter can be used, it is only necessary to place the multimeter in the circuit instead of the meter and R_4. The multimeter is then set to the lowest milliamp range that will allow the full unbalance current to read at less than full-scale, and the maximum current between A and B is measured. Suppose this turned out to be 7 ma. It would then be possible to use a 0-5 ma. movement, with a small series resistor, instead of a 0-1 ma. meter and a larger value of R_4.

If exact values have not been chosen for R_5 and R_6, and the latter has been made variable, as suggested above, the setting-up procedure is the same as before, except that the first step after letting the receiver warm up is to disconnect the meter, and adjust R_6 until the point B is 3 volts positive to chassis. This can be done with the voltmeter (1,000 ohms per volt) connected between B and earth. When this has been done, the rest of the process is exactly as outlined. R_6 is adjusted only the

(Concluded on page 44.)

A Practical Beginners' Course

PART 27

SOME MORE ABOUT AUDIO AMPLIFIERS

Having learned something about the characteristic curves of valves, we can now turn our attention again to more practical things, and in particular to the subject of audio amplifiers. So far, we have described only one set which uses a valve other than the detector, and this was described in Part 23 of this Course, in Fig. 32. This set, it will be remembered, used an audio transformer, with its primary connected in the plate circuit of the detector valve, and the secondary winding connected in the grid circuit of the audio amplifier. This kind of arrangement is known as "Transformer Coupling" to distinguish it from other ways of transferring the audio voltage from the detector plate circuit to the amplifier grid circuit.

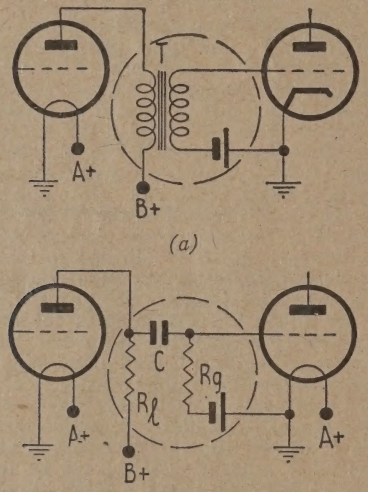


Fig. 35.

There are a number of different ways of doing this, and by far the commonest to-day is not transformer coupling at all, but is called "resistance-capacity coupling." We have illustrated the two types of coupling in Fig. 35, in order to show the similarities and differences between them. In Fig. 35 (a) we have the "bones" of a transformer-coupled stage. This shows the detector valve, the coupling transformer, the bias battery, and the amplifier valve. All the components in front of the detector plate and after the amplifier grid have been omitted so as not to complicate matters, and a dotted circle has been drawn round the part of the circuit that couples the two valves together. In Fig. 35 (b) we have a resistance-capacity coupled stage. Here again we have the detector and amplifier valves, and also a dotted circle enclosing the coupling circuit. In this diagram the transformer is replaced by two resistors and a condenser, which explains right away why resistance-capacity coupling is used so much. The resistors and condensers are many times cheaper than a transformer of any sort, and a high quality transformer is worth several pounds more than an ordinary one. Thus, when it is realized also that properly-designed resistance capacity coupled amplifiers can give just as good results as those using the most expensive transformers, the choice in normal circumstances becomes obvious!

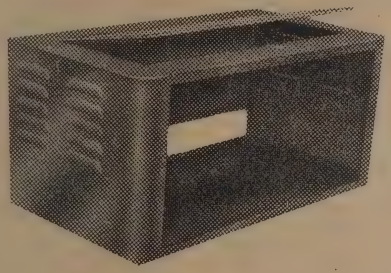
How Resistance Coupling Works

Before saying any more about the relative merits of the two schemes, let us take a look at Fig. 35 (b) and see how this type of coupling works.

Connected between B and the plate of the detector we have a resistor R_1, which is the usual abbreviation for "load resistor." This resistor is there so that the plate current changes in the detector valve can produce a plate VOLTAGE variation. In the previous detector circuits, which had the headphones connected directly in the plate circuit, the variations of plate current actuate the phones directly, causing them to emit sound, but here the phones are in the plate circuit of some succeeding stage, so that unless *something* is connected in series with the plate circuit, there will be no change in plate voltage, even if the plate current is changing. There would then be no alternating voltage developed by the detector that could be passed on to the grid of the amplifier; the load resistor works in this way. The action of the detector causes its plate current to vary according to the audio signal being transmitted by the station that is being received. Now in Fig. 35 (b), this plate current has to pass through R_1, so that the following series of events takes place. When the current passed by the detector valve is small, there is only a small voltage drop across R_1. When the current through the valve is large, there will be large voltage drop through R_1. When the current changes at an audio frequency rate, the voltage across the load resistor also varies at the same rate, and the audio output appears as a voltage at the plate of the valve. The next problem is to transfer this voltage to the grid of the amplifier. It is not possible to connect the grid directly to the plate of the detector, unless very special circuits are used, because were this to be done, the grid of the amplifier would have a high positive bias applied to it. The result would be that the amplifier would pass such heavy plate current as to destroy itself, and at the same time it would not be able to amplify at all. In the transformer-coupled amplifier, the transformer solves this problem for us, because there is no direct electrical connection between the primary and secondary windings. Here, however, we call into play one of the most useful properties of an electrical condenser, namely, that of being able to pass alternating currents while completely blocking the passage of direct currents and voltages. Thus, we connect a fixed condenser from the plate of the detector valve to the grid of the amplifier valve. The audio voltages developed at the plate of the former are therefore applied to the amplifier grid, and yet the condenser blocks the D.C. plate voltage from it, so that we can now place the amplifier grid at whatever D.C. potential we please. This is where the second resistor R_g comes in, in conjunction with the bias battery, which has the same purpose as in a transformer-coupled stage. The purpose of R_g is simply to provide a D.C. path from grid to filament of the amplifier valve. This resistor is not needed in a transformer-coupled amplifier, because the secondary winding gives a D.C. connection to the filament for the grid. In both cases, we have the bias battery, which completes the grid circuit, and at the same time sees that the grid voltage for the amplifier tube is correct. Sometimes, as for example when the plate voltage being used is very low, it is possible to work the amplifier with zero bias, and in this case, the battery

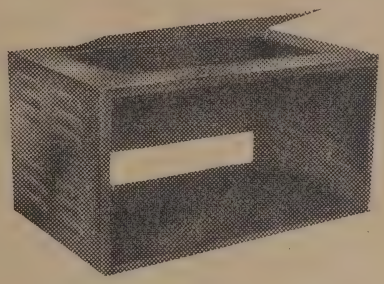
We make Chassis and Cabinets in all Sizes!

Calverts can supply you with the right Chassis or Cabinet to give your transmitter the professional touch. Read our prices and order now.



ALL-PURPOSE SINGLE-UNIT CABINETS. ROUND OR SQUARE ENDS Wrinkle-finish.

£2/5/- each



Round ends 22″ x 10″ x 12″

Square ends 19¼″ x 10″ x 12″

Calverts Limited

138 Tuam Street

Christchurch, N.Z.

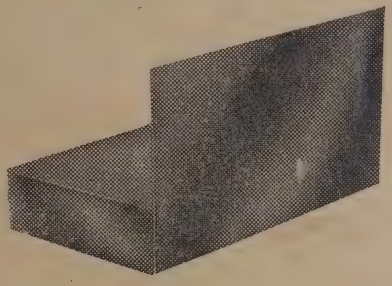
PANEL AND CHASSIS COMBINATIONS

Wrinkle-finish

Chassis 17″ x 11″ x 3″.

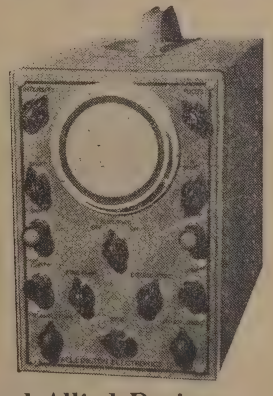
Panel 19″ x 10″.

35/- unpunched



WELLINGTON ELECTRONICS LIMITED

MODEL "A"-3″ OSCILLOSCOPE



High-grade Performance in a Small Space.
Hard Valve Timebase. Video Amplifier.
Weight only 20 lb. Dimensions, approx. 6½″ x 10″ x 13″

●

Manufacturers of Stroboscopes, Oscillators, Electronic Piano Tuners, etc. Specialists in all types of Electronic Counting and Timing Equipment.

●

Consult us for

Scientific and Industrial Application of Electron Tubes and Allied Devices.

Wellington Electronics Ltd., 33 Harris Street, Wellington, C.1.

would simply be omitted, and the lower end of the transformer secondary, or the lower end of R_g, would be connected to earth, or Filament —, which is the same thing.

Another Way of Biasing an Audio Amplifier

So far we have not used anything but battery valves in the sets that have been constructed during the course, but before long we will have reason to use what are commonly known as A.C. valves. These are the ones that are used in all ordinary sets that run off the A.C. mains, and it is to this fact that the name refers. Readers may at times have wondered whether there is some mysterious difference between battery and A.C. valves, and whether or not they are similar in principle. They are, in fact, exactly similar in the way in which they work, and their principles of operation are identical. The only difference is that A.C. valves, instead of having only a filament, have a *heater* and a *cathode* which together perform the same job as the filament in a battery valve. The way in which a heater-cathode valve differs from a filament one was described in an earlier instalment, and in many ways the valve with heater and cathode is easier to apply. One of these ways is in the provision of grid bias. In Fig. 36 (a) we have a new circuit which represents an audio amplifier which is resistance-coupled to the stage in front of it. This stage has not been drawn, because it plays no part in the argument which follows. In Fig. 36 (a) we have the grid resistor shown, and this is connected directly to earth. Now in biasing this valve, it would be possible to use a battery, just as for a filament type tube, and if this were to be done, the cathode would be connected to earth, and the battery inserted in series with the bottom end of the grid resistor. In Fig. 36 (a), however, there is no battery shown, and instead, a resistor is connected between the

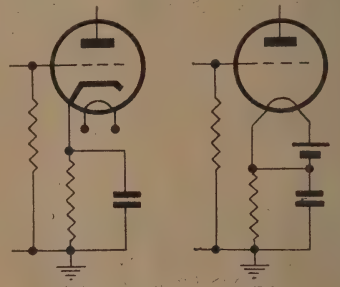


Fig. 36.

cathode and earth. How, then, does this resistor provide grid bias for the valve? The tube, when acting as an amplifier, passes a steady plate current upon which is superimposed a variation that is the audio signal. This variation is short-circuited to earth by the condenser which is shown connected across the *cathode resistor* as it is called. Thus, there is no alternating component of plate current flowing through the cathode resistor at all, and we can forget about this in our calculations. Now, the D.C. plate current of the valve causes a voltage drop in the cathode resistor, and it is in such a direction

(Continued on page 47.)

BEACON TECHNICAL TOPICS

No. 9 Cathode Ray Oscilloscope Power Supplies

Flux leakage, peak inverse voltage, rectifier tube ratings, and condenser working voltages all demand attention when designing a cathode ray oscilloscope power supply. Bulky transformers with a more than usual number of windings on one core are expensive to make if one if the windings has a large number of turns of fine-gauge wire and insulation requirements are severe. These conditions are found in the usual oscilloscope power supply transformer, and often a rewind is required merely because the winding of fine wire has broken down. An electronic high-tension supply for the cathode ray tube is one way of overcoming this difficulty. Another is to have a special transformer for the cathode ray tube high tension, with the cathode ray tube heater winding, high-tension rectifier filament windings, and high-tension winding only on one core. The associated amplifier voltages are then obtained from a separate transformer of conventional type, or, if desired, from a transformer of special low flux density construction.

BEACON make Cathode Ray Oscilloscope Power Supply Transformers to order. At the moment the variety of rectifier tubes, cathode ray tubes, smoothing condensers, and circuits being used makes it rather difficult to arrive at a suitable range of standard designs. When inquiring or ordering, please, if possible, give the contemplated circuit diagram, together with the tube types and voltages required. This will help solve such problems as the insulation wanted and where to put the necessary electrostatic shields. Do not draw an elaborate circuit if it has already been printed in any of the better class radio magazines; it is usually sufficient to state the name and issue of the magazine and the number of the page showing the circuit diagram.

BEACON RADIO LIMITED

32 FANSHAWE STREET, AUCKLAND, C.1

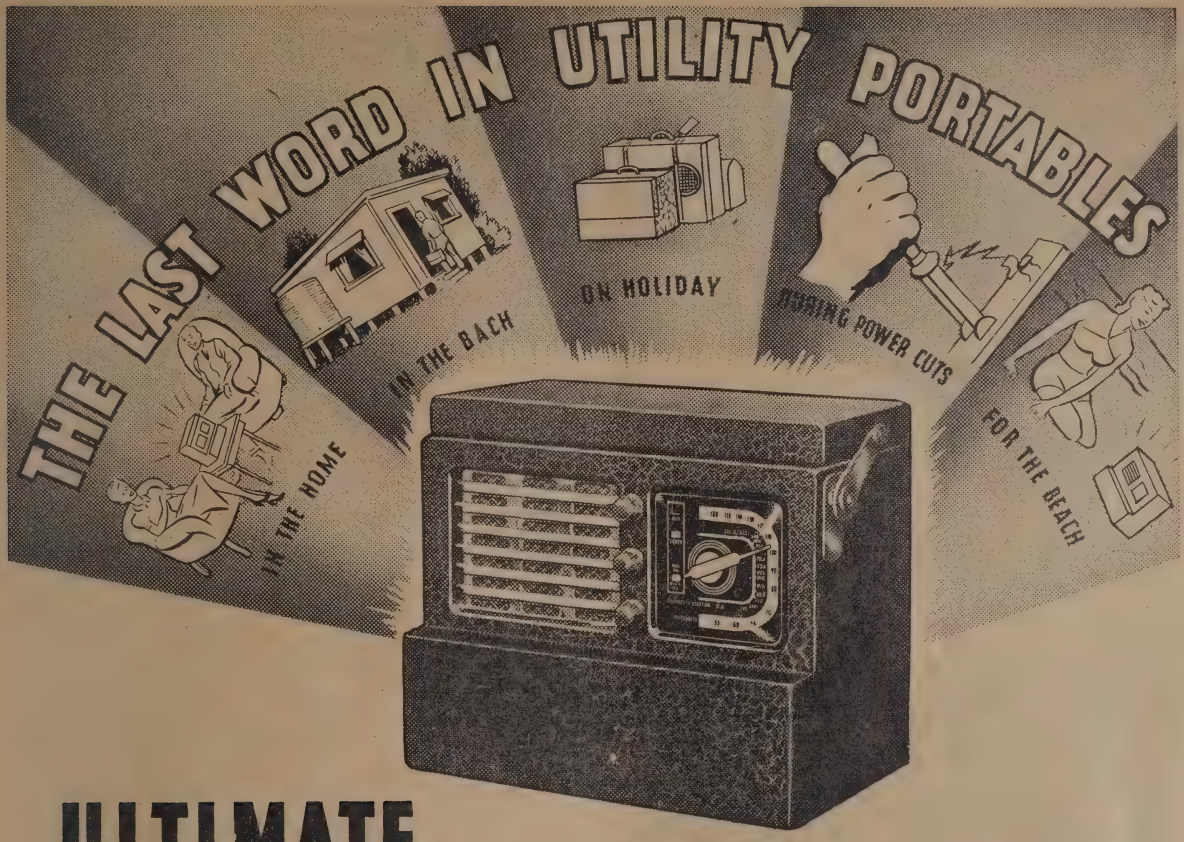
MANUFACTURERS OF CATHODE RAY OSCILLOSCOPE TRANSFORMERS (WHOLESALE ONLY)

If you are not served by one of the Wholesale Distributors mentioned below, please get in touch with us direct.

WELLINGTON
Green & Cooper Ltd.,
43 Lower Taranaki St.,
WELLINGTON

TARANAKI
J. B. MacEwan & Co., Ltd.,
King Street,
NEW PLYMOUTH

OTAGO
R. H. Gardner,
42 Crawford St.,
DUNEDIN



ULTIMATE
6 Valve A.C. BROADCAST and BATTERY PORTABLE

ULTIMATE brings you portable perfection; built-in loop aerial . . . ideal as extra all-purpose radio . . . perfect standby during power cuts . . . excellent out-door set . . . the set you've waited for. Operating on self-contained batteries or plugged into normal power points the ULTIMATE portable is *the* set for the "stay-at-home" or the traveller.

The last word in Radio

ULTIMATE

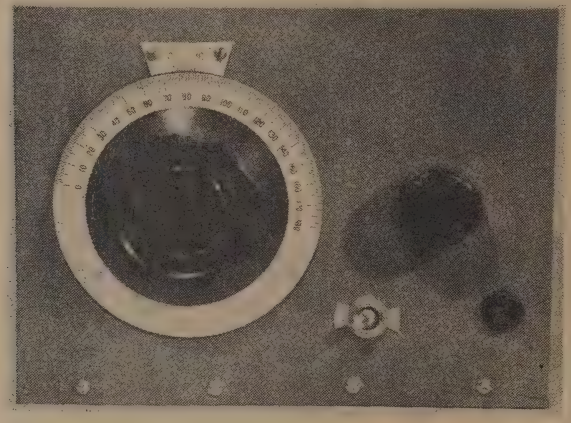
Manufactured by Radio (1936) Limited, Quay Street, Auckland. Dealers throughout New Zealand.

THE RADEL SINGLE-TWIN

There is still a need for small sets, designed especially for new-comers to radio, and for those who want headphone reception and operation from dry batteries with long battery life. This little broadcast set recalls other days, with its 3" diameter coil and tapped aerial winding, and like similar sets that used to be described twenty years ago, it is an excellent performer.

Introduction

This journal does not often publish designs that are particularly suited to radio beginners, apart from the experimental sets that appear from time to time in the "Practical Beginners' Course," and it is felt that we should perhaps cater a little more for those who are experimentally inclined, and whose pockets are a little on the lean side. The little set described here was designed specially for those who prefer to experiment with small battery circuits — in particular, for our younger readers who can perhaps afford a few batteries, but who have not yet got to the stage of using A.C. valves because of the expense of an A.C.-operated power pack. The circuit is not a novel one, but is rather one of those which have so long gone out of vogue for commercial sets, and for advanced constructors, that its particular virtues have been largely forgotten.



Front panel view of the set.

The Circuit

Fig. 1 shows the circuit of the set, which has been called the "Single-Twin," because it has a two-valve circuit, but employs only a single glass envelope, the two sections being inside it, and completely separate as to use. The same circuit could be used by anyone who has two suitable triode valves, since there is nothing about it which makes a dual-purpose valve essential. However, those who are starting from scratch should buy a 1G6-G, in preference to two separate valves of a different type, because the values have been chosen specially to suit this valve, and also because a single dual-purpose valve is cheaper to buy than a pair of separate ones.

The set uses one section of the 1G6-G as a regenerative or oscillating detector, and the other as an audio amplifier. This is the combination that gives the best sensitivity from the least number of valves, whether they are in separate glass envelopes or not, and was chosen for this set because for the money expended on building it, it will give better performance, and enable more distant stations to be received than any other arrangement.

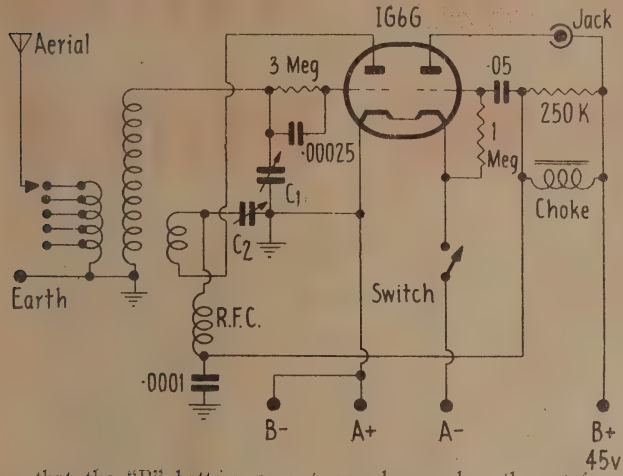
Of recent years, a number of small battery-set kits have been put on the market, and have been sold in large numbers, the special virtues being claimed that they will run off very low-voltage "B" batteries and that, using small coils, they are compact and easily portable. While these claims are no doubt true, it is still true that a well-designed set of this nature will run off as low as 12v. of "B" battery, irrespective of the type of tube used as a detector, and that a small coil, wound with fine wire, and on a small former, is not nearly so efficient as one wound on a large former with heavier wire. Those who remember what sets were like 30 years ago will recall that in those days a four-inch diameter former was considered essential if good results were to be attained, and at that time the coils just had to be efficient, for there were no valves, and the coils themselves had to do all the amplification of which the set was capable. As valves came more into use, and as the art of making valve amplifiers came to be better understood, so the importance of excellent coil design became smaller, although for small sets employing only one or two valves three-inch diameter coils remained in use. Improvements in coil design have made it possible to use very minute coils in sets which have a number of valves, and so has the fact that broadcast stations are now much more powerful than they used to be. However, in a one or two-valve set, even to-day, the situation is just as it was 20 years ago, in that the one coil that is used is itself the most important single part of the set. It is just as important as ever, therefore, to see that a good coil is used.

These are the reasons why we have used a coil wound on a three-inch diameter former for this set. Now, looking at the circuit, it is seen that the coil has three windings. The first, which has several taps brought out from it, is the aerial winding. The purpose of the taps will be discussed later, under the heading of operation. Briefly, it is to enable the set to be made more selective, for when the local stations are on the air, or more sensitive, for listening to distant stations when the locals are off, and the extra selectivity is not needed.

The second (large) winding is the grid coil, and with the tuning condenser makes up the tuned circuit, which not only amplifies the aerial signal before it reaches the valve, but also makes it possible to separate one station from all the others which otherwise would come in with it. The small third winding is the reaction coil, or tickler as it is sometimes called. Its purpose is to provide the regeneration that allows the set to be made hundreds of times more sensitive than it could ever be without. The plate of the detector valve is connected to one end of the tickler winding, while the other end goes, through an R.F. choke, to the iron-cored audio choke. This enables practically the whole of the available "B" battery voltage to be applied to the detector valve, without allowing the audio voltage that is found at the plate of the detector to be short-circuited through the "B" battery. The grid of the audio amplifier is thus fed from the plate end of the audio choke through a 0.05 μf. condenser. The headphones are connected directly in the plate circuit of the audio stage by means of a 'phone jack.

These are the main points in connection with the circuit, but there are a number of small things that should be pointed out in case the builder may think that

they are unimportant. For instance, the connection of the "A" battery should be made in the way shown, and not with the reverse polarity. It is more usual to find the negative terminal of the "A" battery earthed, but here the positive terminal has been earthed on purpose, to ensure that the detector will work at maximum sensitivity. The switch in the A — lead turns the set on or off, and it will be noticed that no provision has been made for switching off the "B" battery. This is quite unnecessary, because when the filament of the valve is cold, it is impossible for any plate current to flow, so

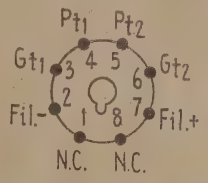


that the "B" battery cannot run down when the set is not in use. Another point is that the grid leak of the audio amplifier stage is connected not to earth, but to A —. This has the effect of placing a small negative bias on the amplifier tube, and thereby of improving the performance somewhat, at the same time reducing the "B" battery consumption.

Constructing the Coil

The most important single item in the set, as we have already stated, is the coil, and builders are well advised to take some pains with its construction. By this we do not intend to imply that the coil is hard to make, but simply that it should be well made if the set's results are to be up to expectations. The main winding is the grid winding, and this should be put on first. The former is three inches in diameter, and a length of five inches of it is required. To put on the grid winding, a hole is made in the former half an inch from the bottom. Then a second hole is made, a quarter of an inch away from the first one, and beside it. These two holes are used to anchor the end of the winding, by passing the wire from the outside through one of them, and back through the other. An end of about six inches is left and this can be used afterwards as one of the connecting wires. The next step is to unwind about ten feet of wire from the reel, and to stretch it by about six inches. This ensures that when the coil is wound the wire will not spring and allow the coil to become slack. When the wire has been stretched, 65 turns are wound on as tightly as possible. The original 10 feet of wire taken off the reel will not be long enough for the whole winding, so that when it is used up one can estimate how much more is needed to finish it, and then unwind and stretch some more wire from the reel, taking care, of course, that the turns already wound on are not allowed to come loose in the process. When the end is reached, two holes are made for finishing the winding, just as it was started, and the wire is taken through them as before, leaving some spare at the end for connecting purposes.

The next winding to put on is the aerial coil. This entails slightly more work than the grid coil, because there are a number of taps to be brought out from it. One way of doing this is illustrated in the photograph. Round the top of the former have been rivetted double-ended connecting lugs, which can be bought at any parts dealers'. In order to start the aerial winding, a single hole is made in the former, $\frac{3}{8}$" above the top of the grid winding. The wire is taken through this hole, from the outside, and then up to a lug, preferably immediately above the starting hole. At the lug, the wire is brought through the former again, to the outside, and is soldered to one end of the lug. Now the first $2\frac{1}{2}$ turns are wound



Above: Base connections of the 1G6G when viewed from under the socket. "N.C." means "No connection."

Left: Circuit diagram of the set. The choke is the primary winding of an old audio transformer. This can be bought second-hand for only a shilling or two.

on, and a finishing hole made in the former. The wire is then taken through, and up to another lug, which is to be the connecting lug for the first tap. Then, to continue the winding, a second wire is soldered to the lug which terminates the first $2\frac{1}{2}$ turns, and is taken down the inside of the former and out through the same hole that was used at the end of the $2\frac{1}{2}$-turn section. The winding is then continued until a total of five turns has been wound on. The five turns are then terminated in the same way as the first section, and tied to a third lug, which forms the connection for the second tap. The next piece of winding consists of five turns, and succeeding sections of five turns are put on until the whole aerial winding of 40 turns has been wound. This gives a total of eight taps, the first at $2\frac{1}{2}$ turns, the second at 5, and succeeding ones at 10, 15, 20, etc.

An alternative way of bringing out the taps, that might be preferred if one does not want to go to the trouble of mounting lugs on the former for all the taps, is to make a tightly-wound loop at each tapping point, and to continue winding. After the whole winding has been put on, the cotton insulation is scraped from the wire, and the wire is fixed with a dab of solder. This method is not quite as satisfactory if much use is made of the taps, as the connection to them of an alligator clip tends to loosen the winding. It is quite satisfactory, however, if the finished winding is painted with shellac varnish. This sticks the coil firmly to the former, and there is then no possibility of its coming loose. Which way is used to bring out the taps can be purely a matter of personal preference. There is no necessity for the taps to be very accurately located, as nothing depends on their exact position. Their use in operating the set will be described later.

The third winding, the reaction or tickler coil, has only ten turns, and is wound over the bottom of the grid coil, the cotton insulation of the wire being relied upon to insulate the two windings from each other. The best way to fix this winding is to spot it on with wax, and

Broadcasting's Silver

each EXTRA RADIO
in the Home means a lot of
EXTRA ENTERTAINMENT
Listen to 1948 programmes on a radio .... Ask your Radio Dealer to let you hear the difference

IS YOUR TO BUILD

THE Radio Manufacturers' Federation has launched this month a Dominion-wide campaign to sell more radios to every home.

This drive, coincident with the celebration of New Zealand's Silver Jubilee of Broadcasting, is *your* opportunity to take advantage of the public's renewed interest in the advances made by Radio —both technically and in entertainment—during the past twenty-five years.

This campaign cannot succeed without your co-operation. With it, the whole industry can achieve new efficiency and strength.

A RADIO IN IS THE IDEAL

Jubilee in New Zealand

BIG CHANCE RADIO SALES

RADIO ADVERTISING:

Special arrangements have been made for strong radio coverage. An average of twenty-five 100-word announcements will be broadcast during each week in November from all the Commercial Stations. This heavy campaign will, of course, take advantage of the publicizing of the Silver Jubilee of Broadcasting in New Zealand by the full network of National Stations.

PRESS ADVERTISING:

Miniature reproductions of the "roughs" of four advertisements appear on these pages. These will appear in 8 in. by three-column and other sizes throughout November in 10 Metropolitan, 20 Major Provincial, and 27 Minor Provincial daily newspapers. They will also appear in 14 monthly and 9 weekly magazines with New Zealand-wide circulations.

WINDOW DISPLAYS:

Window-strips approximately 21 in. x 7½ in. and 40 in. x 15 in. in two colours will be supplied by the Radio Manufacturers' Federation to retailers throughout New Zealand. Retailers will also receive a folder containing suggestions for window displays.

SCREEN ADVERTISING:

Major theatres in the widespread Kerridge-Odeon circuit are being used for a comprehensive Screen-Slide Campaign from 1st to 30th November. Three slides will appear consecutively selling the idea of "a radio in every room."

YOUR OWN ADVERTISING:

YOUR co-operation in your own advertising will help to make this campaign a success—a success in which you will be the first to benefit. Press stereos and blocks are available for including in your current newspaper advertisements, and screen slides with space for your name and address will be obtainable for use in your local theatres. If you use radio advertising, include a "plug" in your copy. By these means, your business will attract your share of the increased sales which this campaign will create.

EVERY ROOM FOR EVERY HOME

Radio can make your Home
the centre of Entertainment
Listen to 1948 programmes on a radio
Ask your Radio Dealer to let you hear the difference
A RADIO IN EVERY ROOM KEEPS YOU IN TOUCH WITH LIFE

A Radio of his own !
Listen to 1948 programmes on a radio
Ask your Radio Dealer to let you hear the difference
A RADIO IN EVERY ROOM KEEPS YOU IN TOUCH WITH LIFE

then, after it has been wound, it is given a coat of shellac, which fixes it permanently in place. The most important thing about this winding is its direction. *It must be wound in the same direction as the grid coil.* If it is not, then the set will not work properly when it is turned on, even though everything else about it is correctly done. As the diagram indicates, the lower end of the tickler coil is connected to the detector plate, and the top end goes, through the R.F. choke, to the audio choke, and to B plus. These connections are correct only if the tickler and grid windings are in the same direction.

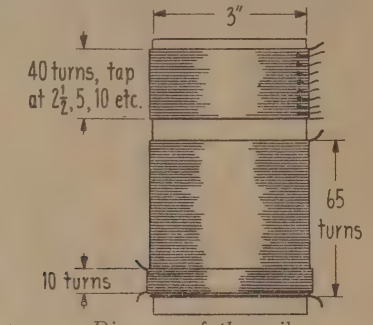


Diagram of the coil.

Constructing the Set Itself

As can be seen from the photographs, the set is built on a wooden baseboard, with a metal panel. It is not necessary for a set of this kind to be mounted on a metal chassis, and the baseboard and panel type of construction makes it easier for beginners, who may not be blessed with a great variety of tools, or with the facilities for making a metal chassis. The baseboard is made of dry timber ¾" thick, and measuring 6" x 8". The metal panel is of 18-gauge steel, but can just as well be made of copper, brass, or aluminium if desired. On the panel are mounted the reaction condenser, the 'phone jack, and the on/off switch, in positions approximately as indicated in the front-panel photograph. The arrangement of the other main parts, which are all mounted on the baseboard, can be seen in the photo of the set which appears on our front cover. The coil is mounted by means of small metal feet, bolted to the bottom of the coil former, and screwed to the baseboard with small wood screws. Behind the coil can be seen the tuning condenser, C_1, and the position of the valve socket can be clearly seen. In the foreground is the audio choke on top of which can be seen the 250k. resistor, in parallel with it, and the 0.05 μf. condenser which is connected between it and the grid of the audio amplifier section of the valve. Along the back of the baseboard is a row of four Fahnstock clips, which are used as terminals for the batteries and the aerial. The one nearest the camera is for B +, the next one for B — and A +, the third for A —, and the fourth, almost obscured by the coil, is the aerial terminal. A glance at the circuit will show that quite a large part of it can be connected up without the coil being in place, and it is a good plan to do this, as it gives more room to work in. In fact, it is a good idea not to make the coil at all until as much of the wiring has been done as is possible, because it is then possible to start and finish the tickler winding and the grid winding at all points that bring the ends nearest to the parts of the circuit to which they are to be connected. As an example of this, the R.F. choke can be seen in the photograph, mounted close to the audio choke, so that the lead from one to the other, though long in the circuit diagram, is short in practice; also, one end of the tickler winding has been positioned so as to be close to the R.F. choke also, thus making a short lead from the tickler to the choke. It is not possible to get a short lead from the reaction condenser, C_2, to the tickler, but this is not important.

In connecting the variable condensers, it is important to connect the moving vanes to the earth side of the circuit. This is because the moving vanes are always connected to the frame of the condenser, so that if C_2 were connected the other way round, and mounted on the metal panel, the panel would then be at H.T. voltage above earth, and the battery would almost certainly be short-circuited when connected to the set. In the case of the tuning condenser, C_1, nothing drastic like this would happen, but the set would be very awkward to handle, through hand-capacity effects. The panel itself should be connected to the earthed part of the circuit. This will ensure that hand-capacity is absent.

It will be noticed that an unusual type of valve socket has been used. This is really one of the chassis-mounting types of socket, usually used for connecting a multi-wire cable to a chassis, and can be obtained at any retail shop. It has been used simply because it is very convenient for screwing to a wooden baseboard. If desired, however, one can use an ordinary octal wafer socket, mounted on two pieces of dowel rod, screwed to the board, and about ¾" high. This has the advantage that all the socket's connecting lugs are in the open, and makes wiring somewhat easier. If the chassis-mounting cord connector type of socket is used, it is necessary to bore a couple of holes in its side, to bring the leads through, and to solder the wires to the pins before it is screwed down to the base.

The connections of the 1G6-G are shown in the diagram on this page, and it should be remembered that the pin numbers refer to the *underneath* view of the socket, with the keyway held nearest to the observer. It does not matter at all which triode of the pair is used for which purpose, since the two sections are identical, but it clearly is important to see that one does not get the connections mixed up so that the grid of one valve is connected with the plate of the other. In this respect it should be noted that on the diagram, Gt_1 means "grid of triode No. 1," and that this grid belongs to Pt_1 which represents the plate of the same section.

There should be no need to go into further detail about the actual wiring of the set, as this will present no difficulty if the lay-out and wiring diagram are followed as closely as possible. In any case, all the salient points have been mentioned.

Operation of the Set

When the wiring has been completed, the first step is to check that everything is correct *before connecting any batteries.* This is very necessary in a battery-powered set, because a mistake in the wiring can easily ruin the most expensive single item in the set—namely, the valve. A good plan is to trace through the wiring, placing a tick or other mark on each connection shown on the circuit diagram, as it is found to be correctly installed, by inspection of the set. In doing this job, take nothing for granted, and imagine that it is someone else's set you are examining. There is then no possibility of "remembering" putting in such and such a wire as the diagram says, when in fact it has been put in wrongly.

The next step is to connect the "A" battery only, and to switch the set on. Of course it will not work, but if the light is not too strong, it will be possible to see whether or not the filament heats up. Having made sure that this happens, the filament can be left on, and the negative "B" battery lead connected. Then, while listening

(Concluded on page 48.)

A Five-inch Oscilloscope Employing Unit Construction

Part 1 of this article described the tube unit, which comprises the power supply for the C.R.T., and the controls associated only with the tube itself, namely, the brilliance, focus, and shift controls. This part describes the amplifiers and time-base, which are built in a separate unit, with all input and outputs brought to terminals, so that in use, the utmost in flexibility is attained.

PART 2

Requirements for Oscilloscope Amplifiers

Before going on to describe in detail the circuits used in this unit, it would perhaps be as well to delve a little into the characteristics that are desirable in oscilloscope amplifiers; this will lend some point to the following discussion of the circuit itself.

First of all, it is very helpful in many instances to have identical amplifiers for both horizontal and vertical deflection. This has the added virtue of simplifying the complete design, since the amplifiers for the two deflection axes can be checked one against the other, if anything is suspected to be not quite right about the performance of one of them. This is a matter of convenience only, and although useful, it is not nearly so important as is knowing that the gain and phase shift of the two amplifiers are identical. This matter will be dealt with more fully when we come to discuss the use of the complete instrument. Also, although the above is a major requirement, it entails no technical difficulty whatever.

The next most important thing when designing the amplifiers for an oscilloscope is to decide what kind of frequency response is required, and although this one, too, may seem simple enough, there are a great many factors to be considered before pencil is put to paper in drawing a tentative circuit.

It is possible, but not easy, to design amplifiers whose response at the low-frequency end is level down to zero frequency. Similarly, it is possible, but again not easy, to design an amplifier whose response extends to about 10 mc/sec. without much loss; and it is possible, but still more difficult, to make amplifiers that will perform these two jobs simultaneously. In theory, of course, the ideal amplifier for the 'scope would be one of these latter, but unfortunately the building of an actual unit is a far from theoretical task, and if anything so ambitious were attempted it would take one man, well versed in the subject, many months' work to complete. It therefore becomes immediately necessary to decide just what frequency response will enable the 'scope to do these things that the builder expects of it. If we were interested mainly in television or radar work, there would be a good case for building in a high-frequency response out to 4 or 5 mc/sec. The same would apply if we were interested to any extent in high-speed pulse work. Fortunately, however, most of us are interested in the audio range, and perhaps a little beyond. If we have any need to display a picture which entails putting R.F. voltage on the deflection plates, it can be done directly, as long as several volts are available, and for amateur purposes the showing of modulation patterns is about the only trick that needs this.

At any rate, consideration shows that except for very specialized applications, by far the greatest number of jobs can be done satisfactorily as long as the amplifiers are flat from, say, 10 c/sec. to 20,000 c/sec., and if they have useful gain up to about 50,000 c/sec. Such amplifiers as this are quite easy to design, and, what is more important to the reader, to build. We will therefore lay down the requirements that the low-frequency response shall be not more than 1 db. down at 10 c/sec., and not more than 3 db. down at 20,000 c/sec. It should be possible to do better than this, without any difficulty.

Gain

The next question to consider is how much gain is needed, and also paradoxically, how much attenuation, in order that the amplifiers can handle large or small signals with equal facility. On the high side, it is desirable to be able to handle signals of 200 volts or more, because frequently one wants to examine the output of an amplifier, where A.C. voltages of this order are to be found at the plates. Thus, if the 'scope amplifier is to be used, an attenuator is necessary ahead of the amplifier. On the other hand, it is often necessary to examine wave-forms of only a small fraction of a volt, so that in order to show a picture of any size on the screen, a good deal of gain is wanted. The C.R.T. itself comes into this part of the discussion, because the signal voltage required to deflect the spot over the whole screen varies according to the tube type. In our case, the 5BP1, or any of its equivalents, needs approximately 200 volts to do this, so that if an overall gain of 300 or more is used, it will be possible to fill the screen from a signal voltage of 0.6v. or less. It should also not be forgotten that the 'scope is seldom used with a picture that fills the screen entirely, because of the distortion that occurs towards the edge of even the best tube of its type. If we want an amplifier gain of three or four hundred, it is comparatively easy to decide on the number of stages, and the types of tube to be used. A single pentode cannot produce as much gain as is required, and for a five-inch tube the maximum undistorted output voltage of the usual small pentode is somewhat limited. Thus, triodes are indicated for the stage which feeds the deflection plates. This stage will have a gain of anything between 5 and 25 times, according to the tube type used, and if a push-pull stage is used, the effective gain will be twice these figures. A similar stage ahead of this will be sufficient to give the total required gain, so that the indications are for the deflection amplifiers each to contain two stages of triode amplification. At this point it is worth mentioning that if we had originally decided on a higher top limit of amplification, two triode stages would not have been satisfactory, unless special precautions were taken to extend the high-frequency response. This would necessitate the use of at least one pentode stage, which would mean considerable complication if other characteristics are to be preserved. In designing this unit we have been at some pains to achieve simplicity of design as well as satisfactory performance, and the latter has been obtained without much sacrifice of the former, in spite of the provision of a number of novel features not yet mentioned.

Other Desirable Features

Having decided the approximate frequency response and gain that is wanted, there are a number of other features that are desirable, and which need to be examined to see if they can usefully be incorporated in the design. An obvious point for decision is whether or not to provide balanced deflection for each axis. The

advantages of using balanced, or push-pull, deflection voltages are so great that it was decided, without further ado, to use them, in spite of the fact that a phase inverter is thereby made essential. Two of the worst forms of distortion that can occur in an oscilloscope picture are trapezium distortion and deflection de-focussing. The first of these gets its name from the fact that its final result is that of showing what should be a rectangle as a trapezium. The larger the tube concerned, the more obvious can this form of distortion become, and so the more necessary it is to correct it. Fortunately, all that has to be done to eliminate it altogether is to feed the deflection plates in push-pull. A good many of the smaller cathode ray tubes (3" and under) do not allow balanced deflection to be used, since one of each pair of deflection plates is connected internally to the final anode (the one that is earthed). This leaves only one plate free for applying the deflection voltage for each axis, so that a push-pull connection is clearly impossible, and any trapezium distortion that occurs has to be put up with. The 5BP1 and its equivalent types, however, have all four deflection plates brought out to base-pins, and there is no difficulty in using balanced deflection if desired.

Since we have decided on balanced deflection, the question now arises that sometimes the voltage that has to be examined is itself a balanced one, as, for example, when one wants to look at the wave-form at the plates of a push-pull amplifier stage, or at the output of a microphone transformer which has a balanced secondary for feeding to a push-pull amplifier. If we are to be able to do this, the 'scope amplifier must have a balanced input connection as well as balanced output. This seems a rather tall order, when it is remembered that most often the voltage to be examined will not be a balanced one, for in these circumstances a phase inverter will be needed.

Fortunately, however, there is a circuit which enables both the above conditions to be fulfilled simultaneously! It is one which readers of this journal will recognize as having been used in a number of receiver and audio amplifier circuits of recent months, and which is rather outstanding in its versatility. Used as a the input stage for the amplifiers in this oscilloscope, it provides the following features:—

(1) Two input terminals, to either of which a single voltage can be applied, resulting in balanced output voltages for the grids of the push-pull second stage.

(2) These input terminals can be used simultaneously for feeding in a balanced pair of input voltages, which remain balanced on passing through the amplifier.

(3) Two entirely independent signal voltages can be fed in, one to one input terminal, and the other to the second, each resulting in an additive or mixed signal which is also balanced.

(4) A gain control can be added to the circuit in such a way that it affects both input terminals equally. Thus, the single control works equally well whichever input terminal of the pair is used for an unbalanced signal, or whether a balanced signal is being fed to the two terminals, as described in (2), or whether two separate signals are being handled as in (3).

While it does not do to be positive in such matters, the writer does not know of any single circuit that will perform all these functions, and, moreover, perform them without recourse to switching. Thus, from the point of view of versatility, the circuit used here can hardly be excelled.

COMPONENT LIST

R_1, R_3, R_5, R_7, R_{14}, R_{15}, R_{28}, R_{30}, R_{32}, R_{34}, R_{36}, R_{40}, 2 meg.
R_2, R_6, R_{29}, R_{33}, 200k.
R_4, R_8, R_{23}, R_{31}, R_{35}, R_{46}, 20k.
R_9, R_{10}, R_{41}, R_{42}, R_{50}, R_{53}, R_{54}, R_{55}, 50k.
R_{11}, R_{38}, 500k. pot.
R_{12}, R_{13}, R_{17}, R_{18}, R_{19}, R_{20}, R_{22}, R_{37}, R_{39}, R_{43}, R_{44}, R_{45}, R_{48}, R_{59}, 100k.
R_{16}, R_{51}, R_{52}, R_{58}, 25k. R_{21}, R_{47}, 1000 ohms.
R_{24}, R_{25}, R_{26}, R_{27}, 250k. R_{49}, 2 meg. pot.
R_{56}, 1 meg. R_{57}, 100k. pot.
C_1, C_2, C_{11}, C_{14}, C_{30}, C_{35}, 0.1 μf. 600v.
C_3, C_6, C_{15}, C_{34}, 8 μf. 450v. Electro.
C_4, C_5, C_{12}, C_{13}, 0.5 μf. 600v.
C_7, C_8, C_9, C_{10}, 16 μf. 450v. Electro.
C_{16}, C_{20}, C_{25}, 0.02 μf. 600v.
C_{18}, C_{23}, 500 $\mu\mu$f. C_{17}, C_{22}, 100 $\mu\mu$f.
C_{26}, 0.25 μf. C_{21}, 0.05 μf. C_{19}, C_{24}, 0.003 μf.
C_{31}, 0.03 μf. 600v. C_{29}, 0.5 μf. C_{27}, C_{28}, C_{33}, 1 μf. 600v.
V_2, V_5, 6N7. V_1, V_4, 6SN7. C_{32}, 0.005 μf. 600v.
V_3, 6AC7. V_6, V_7, 6AC7 or 6SJ7. V_8, 80.
T_1, Power Transformer. Heater windings as indicated. H.V. winding 385v. a side, 80 ma.
L_1, L_2, Smoothing Chokes, 50 ma.
Sw_1, Sw_2, Each two two-pole, three-position wafers actuated from the same shaft.
Sw_3, Three-pole, five positions.

The Unit as a Whole

We are now in a position to examine the complete circuit of the amplifier and time-base unit. V_1 is the first valve in the Y amplifier. An attenuator, giving three steps of attenuation, is connected in front of each of the two inputs to V_1. In order to make operation easier, these two attenuators, which are quite separate electrically, were mounted on the same switch shaft. Thus, it is not possible to have differing degrees of attenuation before the two inputs at the same time, but the convenience of having the attenuators ganged is so great as to outweigh this slight disadvantage. However, if the individual constructor so desires, he can separate the control of the attenuators. The only occasion on which they could possibly be used in different positions at the same time is when the mixing function of the first stage is being used, and when the voltages being mixed are widely different in size.

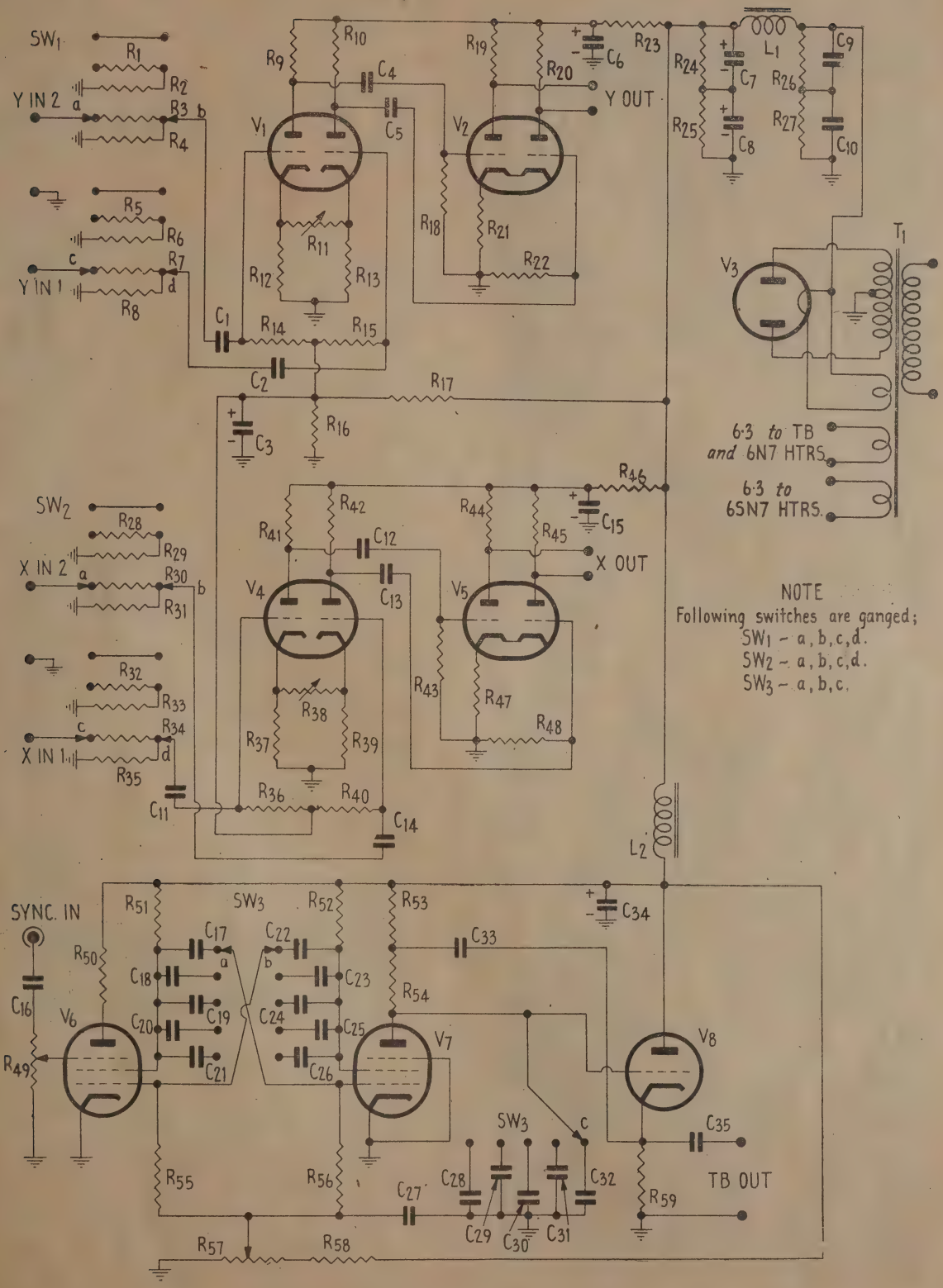
V_2 is a straightforward push-pull amplifier stage, the output of which feeds the Y plates of the C.R.T. Its output terminals are mounted on the back of the unit, as are the output terminals of the other identical amplifier which feeds the X plates of the tube. All other terminals are placed on the front panel so as to facilitate cross-connection between them where necessary.

V_3 is the rectifier which supplies H.T. voltage for all valves in the unit.

V_4 and V_5 form the X-axis amplifier. It is identical in all respects to the Y amplifier, using similar tubes and component values throughout, and having identical ganged attenuators ahead of the input stage.

V_6, V_7, and V_8 form the linear time-base. As can be seen, this is an entirely separate circuit from that of the amplifiers, with the exception that it receives its operating voltages from the same power supply. Readers will no doubt recognize it as the circuit that was first described in the April, 1948, issue of *Radio and Electronics*, with one or two minor alterations.

(Continued on page 29.)


SW1
R1
R2
R3
R4
Y IN 2
a
b
R5
R6
R7
R8
Y IN 1
c
d
C1
C2
C3
R9
R10
C4
C5
V1
V2
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
C6
R23
Y OUT
R24
R25
L1
C7
C8
R26
R27
C9
C10
V3
T1
6·3 to TB and 6N7 HTRS.
6·3 to 6SN7 HTRS.
R46
SW2
R28
R29
R30
R31
X IN 2
X IN 1
R32
R33
R34
R35
C11
R41
R42
C12
C13
V4
V5
R37
R38
R39
R36
R40
C14
R43
R44
R45
C15
X OUT
R47
R48
L2
NOTE
Following switches are ganged;
SW1 – a, b, c, d.
SW2 – a, b, c, d.
SW3 – a, b, c.
SYNC. IN
C16
R49
V6
R50
R51
SW3
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
R52
R53
R54
V7
C33
C34
V8
C35
TB OUT
R55
R56
R57
R58
C27
C28
C29
C30
C31
C32
R59

THESE ARE THE VALVES

IN EVERY FIELD of industrial, scientific, and medical activity — wherever electronics are employed — there you will find Mullard valves and electron tubes. Mullard leadership in Electronics dates from the day, twenty-five years ago, when the first silica valve was made for the Admiralty. Since then a vast knowledge and experience of electronic applications has been accumulated. This is the background to the important research being undertaken to-day in the Mullard laboratories.

Manufacturers of electronic equipment who fit Mullard valves and tubes add to their own wide experience the benefits of Mullard research and development. To the purchaser of such equipment the advantages are clear. He enjoys a double assurance of efficiency and service — he reaps the harvest of Mullard Leadership in Electronics.

Write for valve characteristic chart.

Mullard

The Master Valve

AGENTS:

Auckland: Johns Ltd., Chancery Street
Wellington: Fear & Co., Ltd., 31 Willis St.
Christchurch: Swan Electric Co., Ltd., 83 Lichfield Street
Dunedin: R. H. Gardner, 42 Crawford Street

New Zealand Distributors:
The C. & A. Odlin Co., Ltd., Wellington

TUBE DATA

While crystal rectifiers hardly come under the heading of "tubes," according to their type of construction, they replace valves in their intended spheres of application, and therefore are not so incongruous under this title as might at first appear.

SILICON CRYSTAL RECTIFIERS TYPE CS

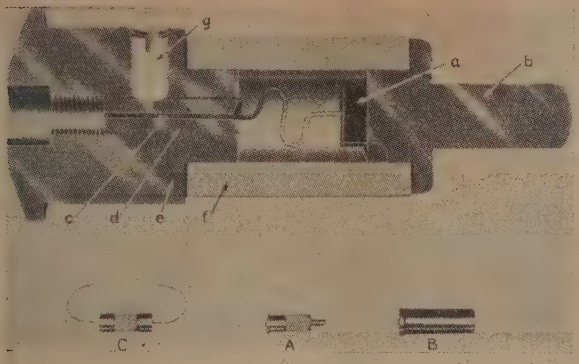


Fig. 1.

CONSTRUCTION

The general construction of a crystal rectifier is illustrated in Fig. 1. A specially prepared flake of silicon *a*, is attached to a silver-plated plug-end *b*, and a tungsten alloy wire contact *c* is soldered to a plunger *d*, which plunger slides axially through the silver-plated head-end *e* of the assembly. The enclosing low-loss ceramic tube *f* is also silver-plated at each end, and this is directly soldered on to the head-end *e* and on to the plug-end *b*, both of which form the end terminals.

Initial adjustment is made by applying axial pressure to the wire contact *c*, Fig. 1, to obtain a pre-determined rectifying characteristic. The plunger *d* is then secured by locking the grub screw *g* in the head-end *e*. The contact pressure is such that the unit will withstand rough handling. Finally, the cartridge or complete unit is hermetically sealed and can be subjected to wide ranges of temperature and humidity without deterioration.

Classification

The standardized nomenclature for silicon crystal rectifiers is *Type CS* ("C" = crystal rectifier, and "S" = silicon), followed by numerals 1 to 6 inclusive, denoting different electrical characteristics, and finally the letters A, B, or C, denoting different forms of assembly. Thus:—

Type CS/1 to 6/A:
A normal single plug assembly as already described, Fig. 1-A.

Type CS/1 to 6/B:
A fully screened assembly, Fig. 1-B, suitable for any specified application up to 10,000 megacycles-per-seconds.

Type CS/1 to 6/C.
A wire-ended assembly, Fig. 1-C, suitable for wiring into a circuit.

Outline Dimensions

The general outline dimensions of the three different forms of assembly of silicon crystal rectifiers are given in Fig. 2.

Electrical Circuit

The equivalent electrical circuit of the crystal rectifier is shown in Fig. 3, where "r" represents the resistance of the semi-conductor, "R" the point contact resistance, "C" the point contact shunt capacitance, and "C_1" the stray capacitance of the entire rectifier.

The importance of making "C" as small, uniform, and constant as possible is apparent when dealing with frequencies of the order of 10,000 megacycles-per-second.

Silicon crystal rectifiers may also be used at lower frequencies in many applications where size, weight, and absence of heater connections are important considerations.

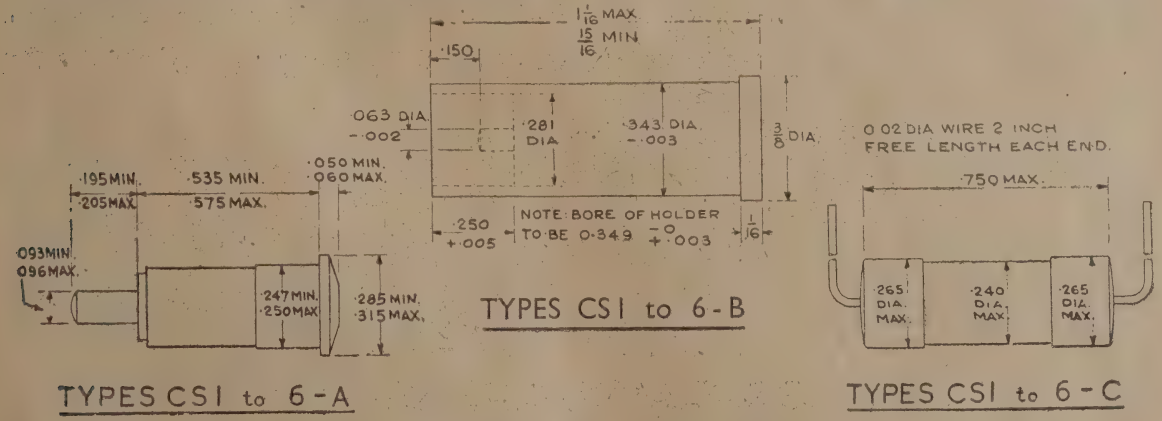


Fig. 2.

APPLICATIONS — TECHNICAL DETAILS

When rectification of alternating currents of very high frequency is an essential requirement, the stable silicon crystal rectifier may be used instead of a diode or any other type of contact rectifier.

As a Mixer or a Converter (Types CS/1, 2, 3, and 5/A and B)

Low impedance, small input, output capacitance, and negligible electron transit time are the chief features which make the crystal an unique generator of the difference-frequency for superheterodyne detection and amplification.

Fig. 4 illustrates one of the many types of crystal holders used in a mixer, suitable for Types CS/1, 2, 3, and 5/A rectifiers; connections to the signal source, beat frequency local oscillator, and I.F. amplifier are shown.

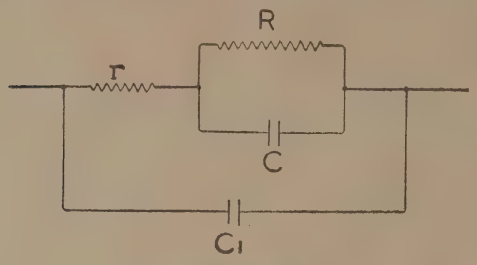


Fig. 3. Electrical circuit.

The position and construction of the R.F. signal by-pass capacitance, which should be limited to about 10 $\mu\mu$f. for cm. wave operation, should be noted.

Conversion Loss (L) is defined as the ratio of the input signal frequency power to the difference frequency power which is applied to the I.F. amplifier.

Noise temperature ratio (t) is defined as the ratio of noise power derived from the crystal converter at the difference frequency to that derived from an equivalent pure resistance under normal operating conditions.

These measurements are usually made in calibrated equipment against standard crystals and the mixers, whether tuned or pre-set, are designed to match the crystal impedance.

Noise Factor (N) defines the overall performance of a receiver, in which the noise generated in the first I.F. stage may be an important contribution, unless design precautions are taken to keep it low. The I.F. noise (n) is that obtained from the amplifier alone when the input resistance of the signal source is equal to the output resistance of the crystal which it replaces in the measurement.

Then $N = L(n + t - 1)$ as defined above. See Table I page 28 for representative values for L and t.

Impedance Matching.—As the input and output impedances of the rectifier will depend upon the circuit and R.F. power levels employed, it is necessary for the user to specify the circuit conditions and impedance limits required.

Local Oscillator Power Unit.—For efficient operation the available power of the local oscillator should be of the order of 100 milliwatts and so permit the loosest possible coupling in the mixer unit. If the coupling is too tight the conversion efficiency is reduced by excessive absorption of the signal power, or else by additional noise, introduced by excessive local oscillator power absorbed by the crystal Optimum coupling corresponds to values of rectified current between 0.3 and 1.0 mA., depending upon design features of the mixer and efficiency of the I.F. amplifier.

As a Low Power Signal Detector (Types CS/4/A and B)

Where only video amplification is employed, the crystal rectifier develops the modulating frequency across a suitable output load. In this application, it is important to use crystals sensitive to small signal powers and to specify the load circuits.

The rectified current developed by the crystal into a suitable load is proportional to the absorbed signal frequency power (P), and the rectified voltage (e) across the crystal is given by the expression:—

$$e = \frac{PR}{b}$$

where R is the output resistance of the crystal, and b is the sensitivity factor for the rectifier.

If, then, the input resistance (r) to the amplifier is specified, the "Figure of Merit" or "Form Factor" of the rectifier is given by the expression:—

$$\frac{R}{b\sqrt{R + r}}$$

In using this formula it is assumed that the input power does not exceed a few microwatts, with the value of R between specified limits and measured with a few millivolts input. See Table I, page 28.

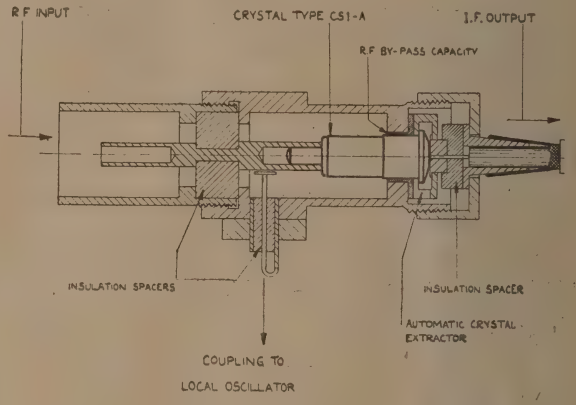


Fig. 4.

As a Meter Rectifier (Types CS/6/A and C)

In its simplest form the crystal is used as a convenient detector in U.H.F. monitoring and measuring equipment, e.g., wavemeters, standing wave detectors, etc. In these applications, the use of low resistance microammeters, not exceeding about 100 ohms, is recommended.

The half-wave rectifying circuit provides a means of measurement up to the limiting frequency imposed by the crystal itself, assuming individual calibration. In this simple form, however, the crystal is exposed to the risk of damage by transient voltage peaks; moreover, the voltage range is limited to the handling capacity of the crystal.

Several unique circuit arrangements have been developed for protecting the crystal and increasing the voltage range.

CHARACTERISTIC FEATURES

Mechanical Strength and Uniformity

Rigid mechanical tests are applied to each crystal in the course of manufacture. It must withstand a tensile strain of 20 lb., applied between the metal ends; or a compression test which does not permanently change the D.C. characteristic; it may, however, vary by not more than 5% during the test. The contact stability of the rectifier is such that it can be dropped on to a hard floor

SOMETHING NEW! . . . .

★ The 1948 'Seven Seas' A.C. Midgets ★

1. The Seven Seas 'ATOM'

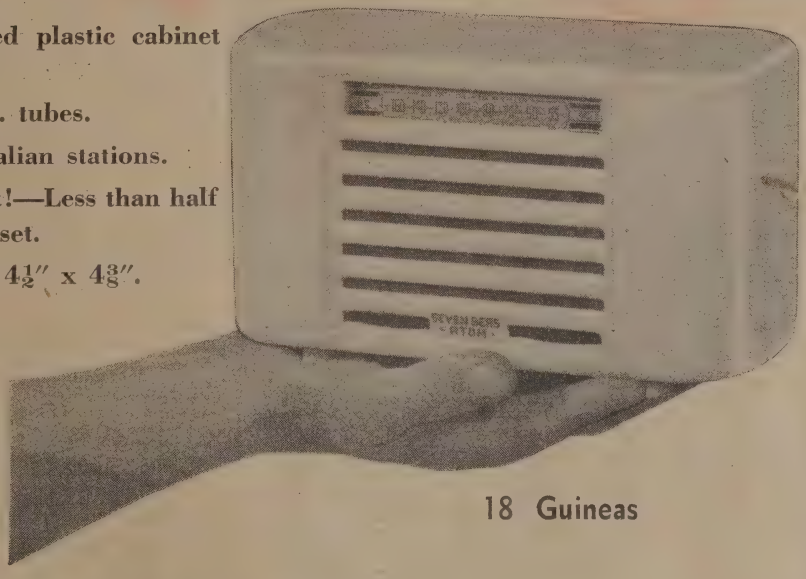
A 5-Valve A.C. Broadcast Super Midget

- Completely enclosed plastic cabinet in rich cream.
- New Miniature A.C. tubes.
- All N.Z. and Australian stations.
- The smallest set yet!—Less than half any present 5-valve set.
- Overall size $8\frac{1}{2}''$ x $4\frac{1}{2}''$ x $4\frac{3}{8}''$.

SEEING

IS

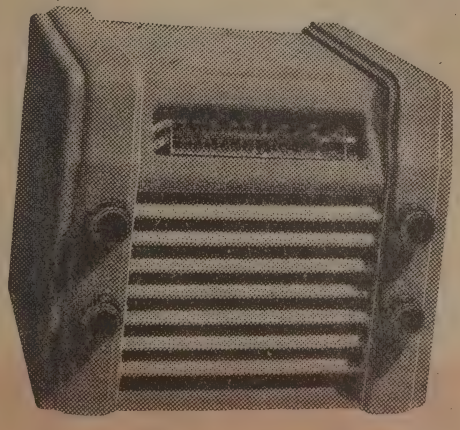
BELIEVING!



18 Guineas

2. The Seven Seas 'JEWELBOX'

A 5-Valve Dual-Wave Midget



24 Guineas.

- New "Silkitone" Cabinet in 3 attractive colours.
- Bass boost tone control for consolette tone in a midget.
- Outstanding performance on both bands.
- Overall size only $9\frac{1}{4}''$ x $8''$ x $7\frac{3}{4}''$.

Territories open for qualified dealers.

Order your samples to-day from

S. D. MANDENO & CO. LTD.

114-121 CHANCERY CHAMBERS, AUCKLAND, C.1

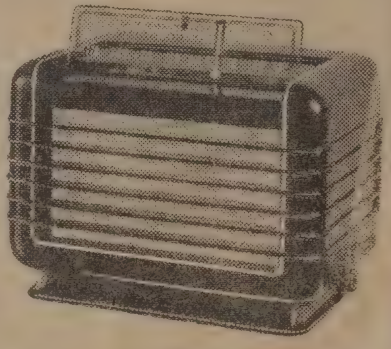
Telegrams: ELECTRONIC

PHILIPS

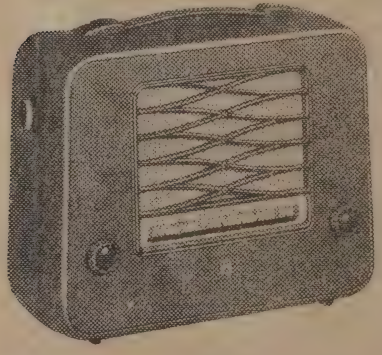
PHILI

Radio Receivers . . . Valves . . . in these four specialize not only in New Zealand, but t are manufactured and market it is the right equipment for i fine service; knowing it is unl friends for you.

PHILIPS RADIOPLAYERS
A COMPLETE RANGE FOR EVERY PURPOSE

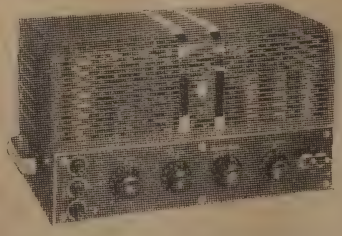


FROM THE popular "baby" sets, right through the range to the magnificent radio-gramophone combination, there's a PHILIPS Radioplayer for every purpose.
Here are the two latest PHILIPS releases. These are setting sales records . . . Radioplayer 209 (illustrated above), a 5-valve broadcast model and outstanding value at £19/19/-, and Radioplayer 545, the 'Double Duty' portable operating from both mains and batteries.



PHILIPS SOUND EQUIPMENT
AMPLIFIERS, SCHOOL SYSTEMS, SPEAKERS

THE *PHILIPS* RANGE covers Sound Equipment for every type of installation — from a single microphone - amplifier - speaker hook-up to the complete requirements of factories, offices, or schools.
Illustrated below is a PHILIPS Power Amplifier—one of many types ranging in power output from 8 watts upwards. Above — the PHILIPS Reflex Exponential Loudspeaker — the most modern development from the PHILIPS Laboratories.



TECHNICAL INFORMATION SER

Behind every PHILIPS product is a comprehensive Technical Information Service. Whatever problem you meet—in radio, in sound equipment, in lighting —PHILIPS can provide the answers that save you time, increase your profit, and ensure the satisfaction of your customers. PHILIPS stockists receive

PHILIPS ELECTRICAL INDUST

COMPLETE SERVICE AVAILA

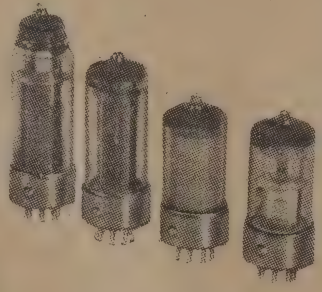
AUCKLAND WELLINGTON

PS BUSINESS BUILDERS ON PARADE

PHILIPS

. . Sound Reproduction Equipment . . . Lighting
elds PHILIPS are recognized as leaders. That applies
ughout the world . . . wherever PHILIPS products
You can sell PHILIPS with confidence . . . knowing
articular purpose; knowing its built-in quality ensures
able value. PHILIPS will build your business and win

PHILIPS VALVES
FOR EVERY TYPE OF RECEIVER



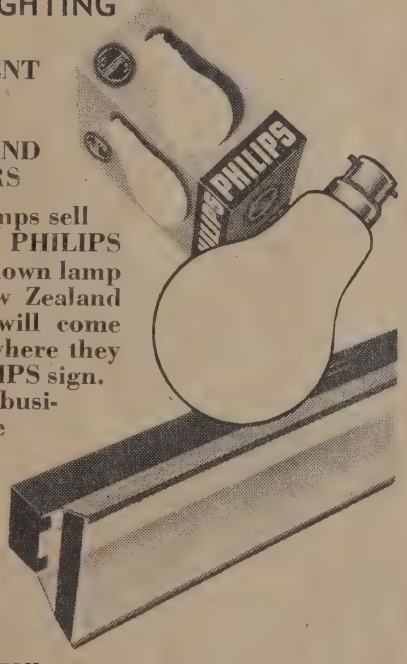
WHATEVER SET you service, the right valves for it are in the Philips range. If you need special-type valves for special purposes, depend upon PHILIPS again. By standardizing on PHILIPS Valves and making full use of the technical information PHILIPS provide, you'll build a sure foundation to success on this side of your business.

CE SECOND TO NONE

regular bulletins, free of cost, keeping them up to date on new developments, showing them the quickest, easiest, approved methods of installing PHILIPS equipment. At any time you can call nearby PHILIPS experts to assist. PHILIPS invite you to make full use of this service.

PHILIPS LIGHTING

FILAMENT
FLUORESCENT
SODIUM
MERCURY
FITTINGS AND
REFLECTORS



PHILIPS Lamps sell themselves. PHILIPS is the best-known lamp name in New Zealand and people will come in and buy where they see the PHILIPS sign. There's big business to be done, too, in fluorescent and other specialized types of lighting. Ask for any information you need from the lighting experts of the Distributing Agents, TURNBULL & JONES, LTD., throughout New Zealand, or from PHILIPS LIGHTING SERVICE BUREAU, Box 1673, C.P.O., Wellington.

RIES OF NEW ZEALAND LTD.

LE AT FOUR MAIN CENTRES

CHRISTCHURCH DUNEDIN

from a height of 5 feet without damage; it must also pass concentricity and other dimensional tests to conform with the specified limits.

Voltage Overload

One of the objections to the use of crystal rectifiers has hitherto been its sensitivity to transient voltage overloads and resulting deterioration or destruction. Improvements in the contact surface treatments have greatly improved its resistance to these effects, but it is necessary to employ protective measures in using and handling the rectifiers in the presence of high voltage transients or in strong R.F. fields. It is customary to provide suitable protection in the form of a gas switch, where the crystal is used with a common transmitting-receiving antenna arrangement. The ceramic type rectifiers are normally enclosed in a lead capsule for protection from strong R.F. fields or static discharge due, for example, to contact with a high voltage source.

crystal capsule is hermetically sealed against the ingress of moisture and it may safely be used in tropical or arctic conditions.

Durability

This will very largely depend upon the nature of service, but, under controlled conditions, the normal life is at least five hundred hours continuous running. The shelf life, if protected as described later, will normally be indefinite, according to available statistics.

PRECAUTION

Handling and Storage

As a protection from damage by strong R.F. fields, Types CS/1-6/A and C are enclosed in lead capsules which should not be removed until the unit is put into service. Type CS/1-6/B is fully protected by its all-metal construction.

The crystal rectifier should be handled with the same care as is customary with valves and, in addition, it must not be brought in contact through the body of the user with unearthed electrical apparatus; nor should wires be soldered to the end electrodes except in the case of the wire-ended type, CS/1-6/C, where the soldering operation must be done with care to avoid overheating the unit. To prevent overheating, the wire should be gripped by a pair of thin-nosed pliers, close up to the metal end, thus ensuring the minimum heat absorption by the unit.

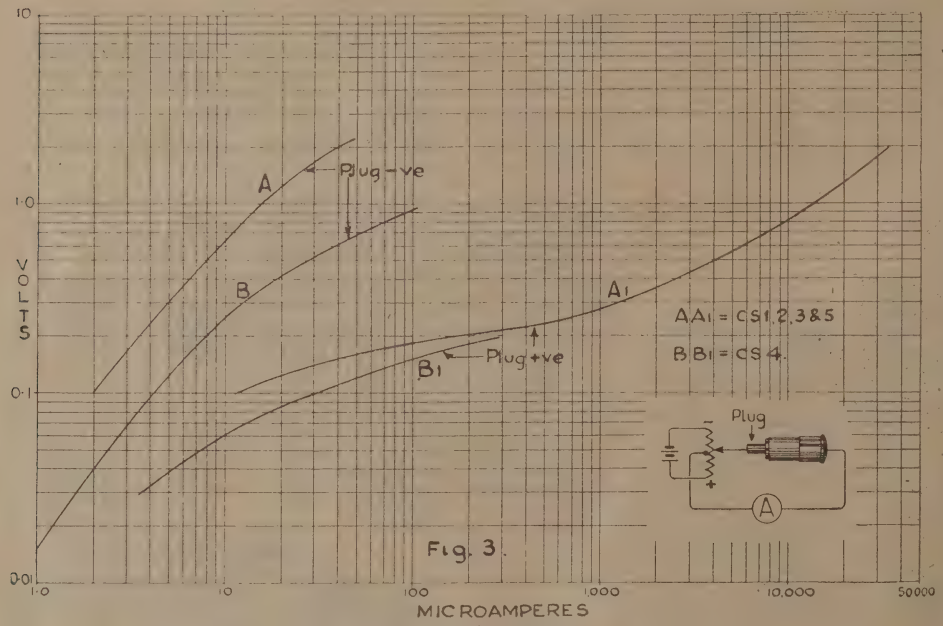


Fig. 5. D.C. characteristics of average Type CS Crystal Rectifiers.

Generally, crystals designed for the highest frequency operation are more sensitive to electric shock than others.

In normal use the deterioration or destruction of the crystal may be caused by excessive C.W. power, peak pulse power, or total pulse energy, if the pulse length is very short, e.g., less than one-tenth of a microsecond. It is therefore necessary to apply one or more factory tests determined by the nature of service. For example, short or long pulses generated by means of artificial lines in which the rectifier is subjected to a discharge, made to simulate the R.F. pulse in a particular equipment, i.e., as a "spike" pulse of the order of three-thousandths of one microsecond or a "long" pulse of one or more microseconds duration; alternatively, a suitable A.C. power test may be applied.

Temperature and Humidity Tests

To meet stringent war-time conditions much work was done to ensure reliability within a temperature range of −40° to +100°C., and with 100% humidity. Each

PERFORMANCE DATA

The following table refers to the numerals in brackets in the table of performance data to be found on the next page.

(1) Up to 5000 megacycles (mcs.).
(2) Average values; measured at 3,000 megacycles (mcs.).
(3) Single D.C. spike energies; duration about 2×10^{-9} seconds.
(4) Continuous maximum voltage and current rating.
(5) Total capacitance of unit is one micro-microfarad ($\mu\mu$f.), average.
(6) Up to 10,000 megacycles (mcs.).
(7) Average values measured at 9375 megacycles (mcs.).
(8) Total capacitance of unit is 0.75 micro-microfarad ($\mu\mu$f.), average.
(9) Not greater than 2.5:1 for admittance measurement, when the rectifier is used in a suitably designed mixer.

AVO

REGD. TRADE MARK

Instruments for the Radio Serviceman

Limited supplies of the following instruments, specially designed for Radio Servicing, are now available:—

HIGH-SENSITIVITY "AVO" METER
20,000 ohms-per-volt movement.
Extended range to cover all requirements.

"AVO" ELECTRONIC TESTMETER
49 ranges. Extreme versatility. High accuracy.

"AVO" TEST BRIDGE
For capacity and inductance testing.

ARRIVING SHORTLY—

THE "AVO" VALVE CHARACTERISTIC METER
A mutual conductance valve tester, specially developed to meet present-day requirements.

"AVO" WIDE-RANGE SIGNAL GENERATOR
An inexpensive R.F. Generator of amazingly wide range and accuracy of performance.

For further details of the above instruments, please turn to page 45 of this publication or contact the sole New Zealand distributors:

The National Electrical & Engineering Co. Ltd.

AUCKLAND WELLINGTON CHRISTCHURCH DUNEDIN
Manufacturers: HAMILTON, WANGANUI HASTINGS
The Automatic Coil Winder and Electrical Equipment Co., Ltd., Douglas Street, London.

Copies Now On Sale!

THE 1948-49 LAMPHOUSE ANNUAL

NEW ZEALANDS BIG RADIO BOOK!

And the Price for all this: 1/- Copy (Plus 3d. Postage)

GET YOUR COPY NOW!

Back to its Big Pre-war Size and crammed from cover to cover with interest, the "1948-49 LAMPHOUSE ANNUAL" is indispensable to your Radio Library.

Contains Circuits of Amplifiers, Battery Sets, Portables, A.C. Sets; pages of Hints and Kinks; Better Results from your Aerial, and dozens of other items of general interest.

Complete Station Logs of all New Zealand, Australian, North American, and the main Shortwave Stations of the World. Also a detailed List of the new Frequency Changes of Australian and New Zealand stations.

Catalogue Section lists hundreds of bargains offered by The Lamphouse, and contains over 400 illustrations.

• • •

"THE LAMPHOUSE,"
11 MANNERS STREET,
WELLINGTON, C.1.

Dear Sirs—
Please post immediately a copy of the "1948-49 LAMPHOUSE ANNUAL" to the address given below. I enclose One Shilling and Threepence (1/3 in Stamps-Postal Note) to cover the cost, 1/-, and postage, etc., 3d.

NAME .....

ADDRESS .....

.....

(Print clearly in BLOCK LETTERS.)

Table I

Type	CS/1/A	CS/2/A	CS/3/A	CS/4/A	CS/5/A	CS/6/A, C
Normal use	Mixer (1)	Mixer (1)	Mixer (6)	Low Level detector (6) (10)	Mixer (6)	Meter rectifier
Characteristics						
Conversion loss (L)	7.5 db (2)	8.0 db (2)	8.0 db (7)	—	8.5 db (7)	Characteristics depend on application.
Noise temperature ratio (t)	1.5 (2)	1.5 (2)	1.7 (7)	—	1.7 (7)	
Proof test pulse	3.75 (3) (ergs)	9.0 (3) (ergs)	1.5 (3) (ergs)	—	9.0 (3) (ergs)	
Proof test A.C. volts	4.0 (4)	6.0 (4)	2.5 (4)	—	6.0 (4)	
Proof test milliamperes (mA.)	45 (4)	70 (4)	28 (4)	—	70 (4)	
Contact capacitance micro-micro-farads (pfds.)	0.5 (5)	0.5 (5)	0.3 (8)	—	0.3 (8)	
Standing wave ratio (S.W.R.)	— (9)	— (9)	— (9)	—	— (9)	

Typical D.C. characteristics are shown in Fig. 5.

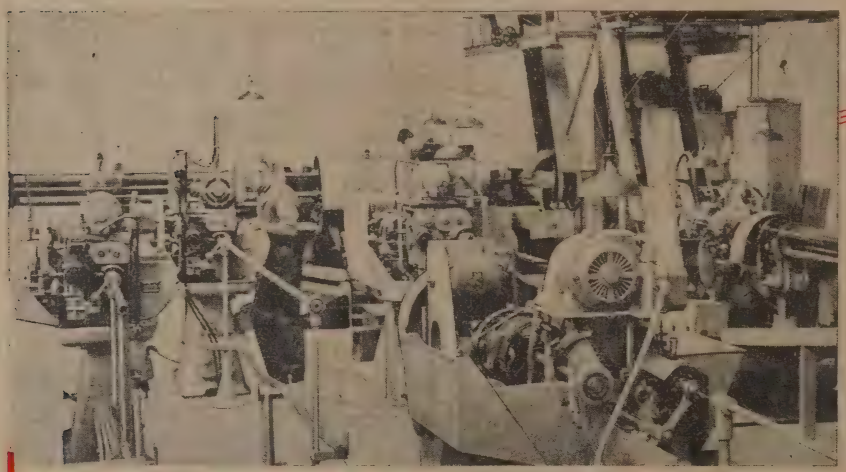
(10) With about five microwatts of radio-frequency (R.F.) input, the rectified current must be greater than 0.1 micro-ampere per microwatt; the low level resistance is between 5,000 and 15,000 ohms at 10 millivolts.

With an input resistance of 1,200 ohms, the "Form Factor" is expressed by :—

$$\frac{1}{b} \times \left\{ \frac{R}{\sqrt{R} + 1200} \right\}$$

where R = Low level resistance of crystal rectifier.

$\frac{1}{b}$ = Sensitivity in microamperes. Output per microwatt input.



Pictured here we show a small corner of our up-to-date Screw Machine Department. In this section of our modern plant, we have installed a comprehensive battery of single and multiple spindle Automatics of the most efficient types, supplemented by all requisite Capstans and subsidiary equipment for secondary operation work.

MASS-PRODUCTION IS OUR FORTE!

- Our background in the machining of components for industry in large quantities extends over several years, and we are confident that you will find our facilities helpful to you.
- We solicit inquiries for the machining of components from bar stock either in brass or steel, in any diameters up to 2¼" round.
- You will be surprised at the extent to which our facilities can assist you in retaining definite cost control on component parts.

AUTO MACHINE MANUFACTURING CO. LTD.

17–20 NELSON STREET, AUCKLAND, C.1. (P.O. Box 179)

5-INCH OSCILLOSCOPE

(Continued from page 18.)

Terminals and Controls

The output terminals have already been mentioned, and in any case these do not appear on the front panel of the unit. On account of the two input terminals for each amplifier, and because the time-base circuit is provided with synch. and output terminals, the total number is quite large, especially when three earth terminals are provided for ease of making connections to the unit. For identification purposes, we will list here both the terminals that are needed on the front panel, and also the controls.

Two Y-input terminals, Y in_1, and Y in_2 on the circuit diagram.
Two X-input terminals, X in_1, and X in_2 on the circuit diagram.
Two earth terminals, one close to each pair of input terminals.
Time-base output terminal, TB out, on circuit diagram.
Synch. input terminal, Synch. In. on circuit diagram.
Another earth terminal, next to the Synch. In. terminal.
Y gain control, R_{11} on the circuit diagram.
X gain control, R_{38} on the circuit diagram.
Y attenuator, Sw_1 on the circuit diagram.
X attenuator, Sw_2 on the circuit diagram.
Coarse Frequency, Sw_3 on the circuit diagram.
Fine Frequency, R_{57} on the circuit diagram.
Synch. Amplitude, R_{19} on the circuit diagram.

The Circuit in Detail

The input stages, V_1 and V_4, of the two amplifiers employ 6SN7's in the cathode coupled or "long-tailed pair" circuit. This was fairly fully described in the June, 1948, issue of *Radio and Electronics*, in an article entitled "A New Triode Audio Amplifier," in which it is used as a phase inverter and audio mixer. The only modification here is that the cathode resistor, instead of being common to both sections, is split into two, each one being twice the value that would be required if the single resistor were used. Referring to the circuit of V_1, these resistors are R_{12} and R_{13}. They are then bridged by a variable resistor, R_{11}, which forms the gain control. When this resistor is reduced to zero, the circuit is equivalent to that of Fig. 1, and the gain is a maximum. When all the resistor is in circuit, the gain is a minimum. By this method of gain control, it is not possible to reduce the gain to zero, but the ratio of maximum to minimum gain attainable is in the region of 10 to 1. This enables the attenuators to be made so as to step down the input voltage by factors of 10 and 100. There are then no "gaps," and any signal at all can be accommodated on the C.R.T. screen by a proper selection of the attenuator setting and the continuous gain control, between the limits of the smallest signal that will produce a useful picture, and the largest that will just fill the screen with both the attenuator and the gain control set at minimum. The grid leaks for V_1 are R_{14} and R_{15}. They are returned to the junction of R_{16} and R_{17}, which provides the positive potential necessary to make the operating grid bias correct.

This voltage divider is the only part of the circuit that is common to both sets of amplifiers. Looking at the X amplifier circuit, it will be seen that the junction of R_{36} and R_{40} is also taken to the junction of R_{16} and R_{17}. This was done because there is no point at all in providing a separate voltage divider for the X amplifier. The voltage to which the grid leaks are returned is not so critical that separate dividers are necessary, and in fact it is not critical at all. The only thing that might have made separate networks advisable would have been "cross talk" between the two amplifiers. However, with the present arrangement there was no sign of interaction. There is nothing unusual about the circuits of V_2 and V_5, the 6N7 second stage amplifiers. Their cathode resistors have not been bypassed, because if the input to these valves is properly balanced, there will not be any audio voltage across the cathode resistors, and if there is, due to a slight unbalance in the phase inverter stage, the unbypassed cathode resistor will help to balance the signal as it passes through the 6N7. It will be noticed that separate decoupling arrangements have been used in the H.T. feeds to the X and Y amplifiers. These, R_{43} C_6, and R_{46} C_{15}, serve to isolate the amplifiers from each other in such a way that should one of them be overloaded, and cause the H.T. voltage to vary slightly, this behaviour will not affect the performance of the other amplifier. These conditions are often met with in a 'scope, because it is possible to have one amplifier, or even both, driven far past the overload point, without any ill-effects, because the distorted portion of the waveform is not on the screen and therefore can be neglected. This situation occurs because the undistorted voltage output of the second stage is more than enough to fill the face of the C.R.T., and a good example of it is when the X gain is wound well up in order to examine the detail of the picture. The input voltage is then much greater than is needed to over-swing the amplifier, but the portion of the output waveform that is seen on the screen is undistorted, because it arises from the linear portion of the amplifier's characteristic.

Another point worthy of mention is the use of an extra smoothing choke and condenser to feed the time-base circuit alone. This is most necessary with this particular time-base, as it is extremely sensitive to hum in the H.T. If this is not smooth enough, the effect is one of multiple traces, because the multivibrator becomes frequency-modulated by the hum, and successive traces start at slightly different times with respect to the wave that is being examined. However, the extra smoothing takes care of this quite effectively, and no trouble should be encountered from this source.

On the power supply, two heater windings have been specified. One of these is used to feed the 6SN7's, V_1 and V_4. These valves have their cathodes at quite high D.C. potential above earth, and although there is no danger of break-down in their heater-cathode insulation, feeding their heaters separately is a worthwhile precaution against hum arising and being amplified by the second stages.

Since the load on the power supply is quite light (of the order of 30 ma. or so), the output voltage of the power supply will be between 400 and 500 volts. It is for this reason that series electrolytic smoothing condensers have been specified in the circuit diagram. It is more important than usual that test instruments such as a 'scope shall be more trouble-free than the receivers, transmitters, etc., that are to be tested, so that although in some circumstances one might be tempted to try and get away with single smoothing condensers, this is hardly the place for doubtful practice. Nothing is more annoying than having to service test instruments when one comes to use them and finds that they are unserviceable.

Type of Construction Used

The chassis drawings given on this page show the type of construction that was used for the original unit that was built, and is now in daily use in our own laboratory. The front panel has the row of terminals along the

bottom, and the other holes indicated are for the controls. Taking the terminal holes, from left to right, we have Earth, Y in$_1$, Y in$_2$, Synch. In, Earth, Time-Base Out, X in$_2$, X in$_1$, and Earth.

The second row of controls, reading from left to right, are: Y gain, Y attenuator, Synch. Amplitude, X attenuator, and X gain.

The third row, also from left to right, are: Blank, Blank, Coarse Frequency, Fine Frequency, and another blank. The two holes in the top row are also blank. The blank holes were included to take care of possible additions to the unit that have not yet materialized. The main addition that was envisaged was a small high-voltage power supply for a 2¾" cathode ray tube that could be used instead of the 5" tube unit when the latter was in use elsewhere, without the amplifier and time-base unit, thus giving two 'scopes for only a small extra amount of work on the amplifier unit. The small tube is to plug in at the back of the unit, and could be used for applications where the amplifiers are always needed. Thus, extra holes were left on the panel for the brilliance, focus, and shift controls for the small tube. Also shown on the chassis is an extra valve hole which could be used for the high-voltage rectifier, and another which could be used for a single-stage amplifier, separate from the main amplifiers, and to be available for brilliance modulation of the 5" tube. However, none of these additions have been made as yet, and our purpose here is to present the main amplifier and time-base unit without needless complication. The chassis diagram can easily be used by deleting the holes that are not required, or by leaving them unoccupied. No doubt other additions will occur to the builder when he has made the first part of the circuit function satisfactorily.

The holes in the back of the chassis are for the X and Y output terminals, the power lead, and the socket for the extra small C.R.T.

The positions of the tubes on the chassis are as follows. Looking at the chassis diagram, the two valve holes at the left are for the Y amplifier valves, with V_1 at the front, and V_2 behind it. The similarly placed holes at the right of the chassis are for V_4 and V_5 respectively. The other four holes in the two front lines are for the time-base valves, V_6, V_7, and V_8, with one spare for possible additions. Of these four, the back two are used for V_6 and V_7, with the former at the left and the latter in the right-hand one. The right-hand front one is used for V_8, leaving the left-hand front one vacant. Thus, reading along the two front rows of valves from left to right, we have V_1, blank, V_8, and V_4 in the front row, and V_2, V_6, V_7, and V_5 in the back row. Either of the holes beside the power transformer cut-out can be used as the rectifier, V_3. While this chassis may seem a little large, it is a good plan to have plenty of space about it, as it facilitates the wiring and placement of parts, of which there are a good many.

It will be noticed that the hole for the coarse frequency control, Sw_3, comes above the level of the chassis top. This has been done to relieve congestion under the chassis. The switch itself is mounted on a bracket between and slightly in front of the holes for V_6 and V_7. This switch has two wafers, one a double one, which is used for the condensers C_{17} to C_{26}, the multivibrator grid-screen coupling condensers, and the other, a single one for switching the charging condensers C_{28}-C_{32}. The former two banks of condensers are mounted above the chassis, and the latter below. If an attempt had been made to mount all of them underneath, the crowding would have made wiring very awkward. The rather long leads to R_{57} are of no consequence, as they are carrying only D.C. All other controls are so placed as to give conveniently short leads to the valve pins. However, this type of construction is only given here as a suggestion, since any suitable lay-out can be used, conventional audio practice being followed.

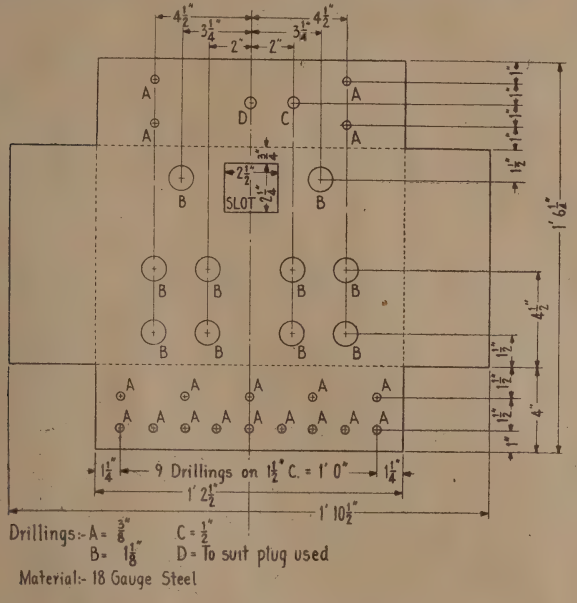
The attenuators have three positions, the first of which connects the grid of the valve straight to the input voltage without attenuation. The second position gives an attenuation of 10 times, and the third one of 100 times.

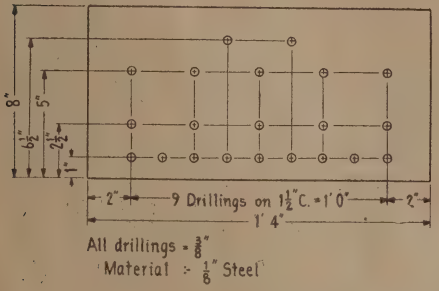
Points to Note when Using the Unit

Since the design of the amplifiers and time-base is so straightforward, there will be no difficulty in operating it once constructed. However, one or two tips should not be out of place here. The first one has to do with the way in which the connections are made between the tube unit and the amplifier unit. This is very simple, because there are only the four deflecting plate terminals on the tube unit, and the four output terminals on the amplifier unit. Since both amplifiers are the same in all respects, either amplifier can be used for supplying the signal to either set of deflecting plates. We have labelled the amplifiers X and Y purely for convenience, for the one that will normally be used for the X-axis is the one whose input terminal is nearest to the Time-Base Out. terminal. Also, it is more or less standard practice to have the Y amplifier on the left, and the X amplifier on the right. However, it is convenient when using the 'scope with its amplifiers to have a standard method of connection for the outputs of the latter, for the following reason. In drawing graphs of any sort, the mathematical convention is to have positive quantities represented, on the Y-axis, by moving upwards from the origin, and on the X-axis, by moving to the right from the origin. Thus, too, the standard method of connecting an oscillo-

SIEMENS
ELECTRIC LAMPS
•
Used for
Lighting
Big Ben
and just as **Reliable!**
•
Cory-Wright & Salmon Ltd.
Wellington
Auckland .·. **Dunedin**

scope, which after all is only an electrical way of drawing graphs, is to make positive deflecting voltages move the spot upwards, for the Y-axis, and to the right for the X. That is to say, at the input to the amplifiers, the positive half-cycle of the waveform being displayed should cause the spot to deflect upwards in the case of the Y amplifiers, and to the right in the case of the X amplifier. Here we have two input terminals to each axis, and it is possible to connect the output terminals to the deflecting plates in either of two ways. Thus, we label one of the input terminals Y in$_1$, and this should be the one to which a positive voltage can be connected in order to make the spot move upwards. To see if the output terminals have been connected the right way round to bring this about, connect the negative terminal

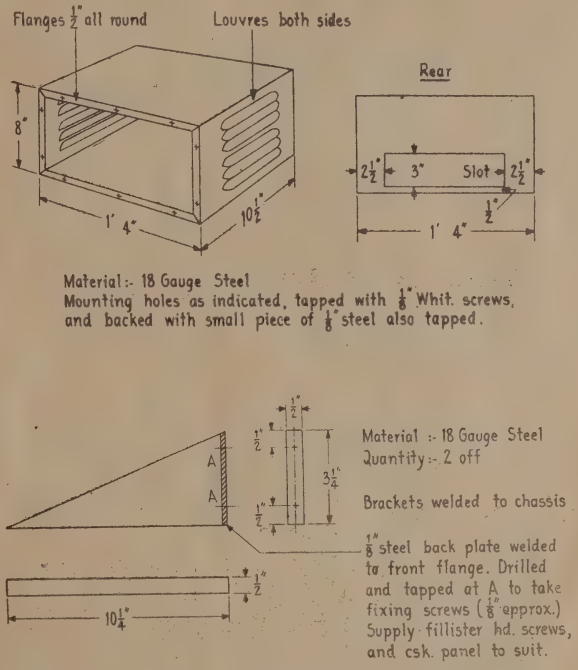




of a 1.5v. cell to the earth terminal, and then momentarily touch the positive terminal of the battery on to the Y in$_1$ terminal. If the spot flies upwards on touching the battery on, then the polarity is correct. If not, the output leads to the deflecting plates should be reversed. When this has been done, the amplifier output terminals, the deflecting plate input terminals, and the connecting leads should all be marked in such a way that every time the connections are made the polarity will be the same. The same procedure should be gone through for the X amplifier and deflection plates, as this will ensure that when the time-base is connected to X in$_1$ terminal, the spot will move from left to right during the rise of the saw-tooth, and back from right to left during the fly-back.

It may not seem very important to standardize the connections in this way, but it saves a great deal of worry later on. For instance, if the output waveform of an amplifier stage is being examined, and flattening off is observed on one peak, and not on the other, it is very necessary to know whether this is due to the valve being driven to cut-off, or to grid-current. If the connections have been standardized in this way, one knows at a glance whether it is the positive or negative peak that is affected, and therefore whether cut-off or grid-current is the cause of the distortion. If one has first of all to find which peak is which, a good deal of time is wasted.

Another point is that when only one input terminal is being used, the other should be connected to the nearest earth terminal. If it is left floating it may pick up hum, to the detriment of the picture. Also, one should not rely


Flanges ½" all round
Louvres both sides
Rear
Slot
Material :- 18 Gauge Steel
Mounting holes as indicated, tapped with ⅛" Whit. screws, and backed with small piece of ⅛" steel also tapped.
Material :- 18 Gauge Steel
Quantity :- 2 off
Brackets welded to chassis
⅛" steel back plate welded to front flange. Drilled and tapped at A to take fixing screws (⅛" approx.) Supply fillister hd. screws, and csk. panel to suit.

Working drawings for the chassis and cabinet of the amplifier and time-base unit.

on the earths on the power leads to connect the amplifier and tube unit chassis together. They should always be connected by means of a separate earth lead.

With the terminal arrangement shown for connecting and disconnecting the time-base, no provision has been made for turning this off, as it is merely disconnected when not in use. If it is left running on one of the high-frequency ranges, it may radiate enough to cause interference to the picture. If this happens, all that needs to be done is to switch it to one of the low-frequency ranges.

This covers all that needs to be said about the amplifier unit. The performing of various tests, and the different ways in which the whole set-up can be used, will be dealt with in the next and final instalment of this article.

Radiotrons . . .

Availability of American Type Tubes

Radio manufacturers and servicemen will be glad to hear of the availability of Australian-made Radiotron valves. For your convenience production details and types available are listed below:—

★ IN CONTINUOUS PRODUCTION:—

Miniature Battery Operated Series
- 1R5
- 1S5
- 1T4
- 3S4
- 3V4

6.3-volt A.C. Miniature Series
- 6AU6
- 6BA6
- 6BE6
- 6AV6

2-volt Series
- 1C7G
- 1K7G
- 1L5G
- 1M5G

6.3-volt A.C. Range
- 6A8G
- 6B6G
- 6G8G
- 6J7G
- 6J8GA
- 6SJ7GT
- 6SN7GT
- 6U7G
- 6V6GT
- 6X5GT
- 5Y3GT

★ INTERMITTENT PRODUCTION (according to market demand):—

6.3-volt A.C. Range
- 6A7
- 6F6G
- 6J5GT
- 6SA7GT
- 6SK7GT
- 6SQ7GT

Miscellaneous
- 1C4
- 1C6
- 1D4
- 1H4G
- 2A5
- 5V4G
- 30
- 42
- 45
- 47
- 57
- 58
- 75
- 80
- 83V
- 6AQ5

Please note that the above lists are liable to change, as modern research methods make improved types available.

New Zealand Distributors:

THE NATIONAL ELECTRICAL AND ENGINEERING COMPANY LIMITED

Auckland Wellington, Christchurch, Dunedin, Hamilton, Hastings, Wanganui

The Radio and Electronics Abstract Service

AUDIO EQUIPMENT AND DESIGN:

Quality in the home. Discussion in favour of limit of 5 watts output, range 50-20,000 c/s., with reference to the subjects of bass resonance, efficiency, and percentage of distortion in output stage with various types of valves. Choice of suitable valves.—**Wireless World (Eng.), August, 1948, p. 299.**

Recording and reproduction of sound; Part 18. Examination of various types of loudspeakers, placement of speakers, enclosures, and acoustic principles.

—**Radio News (U.S.A.), August, 1948, p. 49.**

Miniature tube high-fidelity amplifier. Circuit and constructional details of a 4-watt amplifier with compressor-expander and pick-up equalizing network, also provision for both microphone and gramophone input. Transformerless power supply (117v. A.C.), with selenium rectifiers.

—**Radio News (U.S.A.), September, 1948, p. 46.**

Recording and reproduction of sound; Part 19. Design data for series and parallel filter-type networks and constant resistance networks used with audio amplifiers.

—**Radio News (U.S.A.), September, 1948, p. 48.**

Wide-range speaker systems. Construction of loudspeaker baffles. Details of construction of vented enclosures for both 12-inch and 15-inch speakers, enclosures being made from ⅝-inch plywood.

—**Radio News (U.S.A.), September, 1948, p. 53.**

A peaked audio amplifier for communication receivers. Circuit and details of construction of amplifier based on twin-"T" resistance-capacitance bridge.

—**Q.S.T. (U.S.A.), September, 1948, p. 16.**

ANTENNAE AND TRANSMISSION LINES:

Small aerials in dielectric media. Details of findings resulting from an investigation of problem in connection with design of Adcock h.f. direction-finding systems of small dimensions. Open aerials and loops were surrounded by dielectric material, dimensions being small compared with wavelength. Particulars of four main experiments. Formula for calculating current in ellipsoidal receiving aerials of conducting or dielectric material.

—**Wireless Engineer (Eng.), August, 1948, p. 246.**

Properties of loop aerials. Non-uniform current distribution. Discussion of equivalent loop and dipole combinations for more common types of loop aerials. Tables give: (1) Equivalent circuits of non-uniform loops, loop moment, and dipole or spaced-dipole moment; and (2) radiation resistance and ohmic loss resistance.

—**Wireless Engineer (Eng.), August, 1948, p. 254.**

Radiation from short aerials. Combining radiation patterns of linear radiators shorter than half-wavelength, radiators spaced in any manner, and with currents flowing which have arbitrary phase differences. Use of a theorem stated as follows: "The phase of the radiated field at a distant point, due to a straight isolated thin aerial of length less than, or equal to, a half-wave, is to a close approximation the same as that of the field due to the current flowing through a short element of the aerial at its current centre of gravity." Several examples of application of theorem given.

—**Wireless Engineer (Eng.), August, 1948, p. 260.**

Antenna matching with line segments. Simple formulae for designing all forms of networks which use a section of line as a transformer.—**Q.S.T. (U.S.A.), September, 1948, p. 18.**

The "Hammock" beam. Details of a reversible 3-element beam for 14 mc. (amateur) band.

Q.S.T. (U.S.A.), August, 1948, p. 21.

CIRCUITS AND CIRCUIT ELEMENTS:

The Synchrodyne. (See **Radio and Electronics, September, 1947, p.9.**) Explanation of operation and principles involved. Suggested modulator circuits and one form of Synchrodyne circuit with cathode-follower stage coupling R.F. amplifier to modulator.—**Wireless World (Eng.), August, 1948, p. 277.**

Negative feedback. Application to wide-band amplifiers. Reproduction of circuit from "Network Analysis and Feedback Amplifier Design," H. W. Bode (Macmillan), with calculation of practical values for parameters. Feedback applied through common low-value cathode resistance.

—**Wireless World (Eng.), August, 1948, p. 283.**

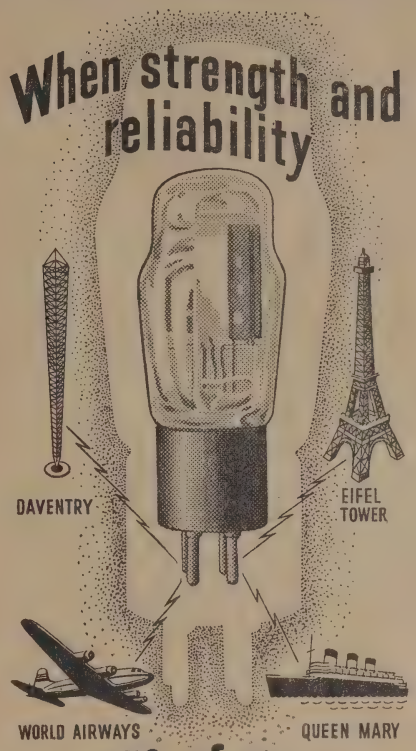
Clippers. Circuit of cathode-coupled limiter to clip waveforms to square or rectangular shape. Employs double-triode valve and has advantage that there is no grid-coupling condenser to be charged, with its consequent negative biasing of valve, as in limiters depending upon grid current.

—**Wireless World (Eng.), August, 1948, p. 283.**

High-stability L.C. oscillator. Bridge stabilized oscillator of good waveform and high short-period stability, designed for 20 kc., providing calibration points at 20 kc. intervals to 1.5 mc. Uses single high-gain pentode valve (6AC7). Feedback provided through a bridge network. Requires input and output transformers of determined ratios.

—**Wireless World (Eng.), August, 1948, p. 286.**

A.F. R.F. signal tracer. Simple circuit using germanium



are of vital importance.. Brimar is installed!

By examining two valves you cannot detect any difference in quality. You are forced to rely on a reputable name. Such a name is Brimar. Brimar valves are in operation in Empire Air Services. Everywhere reliability means lives Brimar are installed.

For strength and reliability always specify—

BRIMAR

BRITISH RADIO VALVES

Standard Telephones & Cables Pty. Ltd. (Inc. in N.S.W.)

Wellington Box 638 Christchurch Box 983
Wanganui Box 293 Auckland Box 91w

crystal rectifier. 0-50 D.C. Microammeter gives visual indication; high-resistance headphones used for aural tracing.

—Radio News (U.S.A.), August, 1948, p. 38.

The Miller integrator. Defined as "a circuit in which a form of feedback is applied to an amplifier, the effect being to constrain the output voltage to be proportional to the integral of the input voltage with respect to time." First of a series of three articles. Basic theory and application. Various methods discussed for controlling pentode so that anode potential falls linearly and returns rapidly to starting-point, e.g., suppressor switching; grid switching and grid leak switching.

—Electronic Engineering (Eng.), August, 1948, p. 243.

Radio frequency E.H.T. supplies. Details of circuit and construction of transformer for 12 kv. R.F. E.H.T. unit. By adjustment described in article, the unit will deliver between 8-15 kv. or, as a half-wave unit, 4-7.5 kv. Oscillator valve is 6V6 (GTG) and rectifier is EY51.

—Electronic Engineering (Eng.), August, 1948, p. 264.

Short-circuited turns. Article which shows mathematically that there is no fundamental difference between action of short-circuited turn in R.F. and in A.F. circuits. Analysis shows that the practical difference is due to higher coupling coefficient between short-circuited section of coil and the remainder—in case of power or audio frequencies—and to localized heating effect of circulating current.

—Wireless Engineer (Eng.), August, 1948, p. 240.

Portable, light-weight 1-tube stroboscope. Circuit and construction of unit using strobotron valve and having frequency range from 10 per second to 112 per second.

—Radio News (U.S.A.), September, 1948, p. 38.

"Super-modulation." First part of an article giving details of a system of modulation, referred to as the Taylor principle, for which considerable advantages are claimed. Super-modulation use of emphasised side-bands and semi-suppressed carrier said to provide far greater signalling efficiency than previously considered possible. Circuits and illustrations of equipment.

—Radio News (U.S.A.), September, 1948, p. 42.

Cathode follower. Notes. Method of overcoming effect of variation of output resistance due to variation of input conditions by use of potentiometer network across H.T. to supply grid bias for C.F. Variation referred to occurs when grid leak taken to tapping on cathode load, as is commonly done. Suggestion for use of C.F. as charging valve in linear time-base.—Wireless World (Eng.), September, 1948, p. 322.

Negative feedback calculations. Simplified formulae and methods for calculating stage gain, stage gain with current feedback, overall amplifier gain, feedback factor and distortion, and output resistance.

—Wireless World (Eng.), September, 1948, p. 326.

High-level detection. Circuit of a quality receiver without an A.F. stage. Diode operating as high as possible on characteristic curve feeds into P.P. triode output stage. Receiver has three low-gain R.F. stages, pre-set tuning, and semi-tunable coupling to diode stage.

—Wireless World (Eng.), September, 1948, p. 330.

Series-capacitor heater circuits. Comparison between series resistor and series capacitor methods of supplying power to valve heaters from the mains. Proved that latter method results in negligible power loss and better regulation.

—Wireless World (Eng.), September, 1948, p. 332.

High-stability oscillator (see Radio and Electronics Abstracts, September, 1948, p. 26). Application of Clapp circuit to V.F.O.—Q.S.T. (U.S.A.), August, 1948, p. 26.

The "Monotone." Circuit and construction of a unit which may be used with the receiver for monitoring C.W. transmission.—Q.S.T. (U.S.A.), September, 1948, p. 22.

FREQUENCY MODULATION:

F.M. detectors. Circuits and explanation of operation of two types of detectors most frequently used in U.S. receivers. The Foster-Seely and the ratio detector.

—Radio News (U.S.A.), August, 1948, p. 56.

Discriminator alignment. The phase discriminator. Design details, thereafter article deals with the alignment procedure, and is intended to show that successful discriminator alignment is possible, since the unit need not have any critical components if correctly designed.

—Wireless World (Eng.), September, 1948, p. 312.

F.M. compared with A.M. Clear explanation of differences between the two systems.

—Wireless World (Eng.), September, 1948, p. 339.

MATERIALS AND SUBSIDIARY TECHNIQUES:

E.C.M.E. Electronic circuit making equipment. A brief historical outline of John A. Sargrove's British machine for automatic production of radio sets using "spray milled" circuit. Excellent illustrations of the various processes.

—Fortune (U.S.A.), August, 1948, p. 90.

MICROWAVE TECHNIQUES:

Microwave plumbing replaces circuitry. Simple explanation of microwave technique, with particular reference to wave-guide theory. Description of composition of basic microwave transmitter.—Radio News (U.S.A.), September, 1948, p. 35.

MEASUREMENTS AND TEST GEAR:

Tolerance testing techniques. Various methods suggested whereby tolerance form of measurements may be made for quantity testing of components.

—Electronic Engineering (Eng.), August, 1948, p. 260.

Accurate frequency measurements. Circuit and other details of a frequency meter capable of measuring to within one part in 100,000. 100 kc. oscillator, 10 kc. multivibrator, amplifier-mixer for increasing harmonic output, and a stable double-range interpolating oscillator.—Q.S.T. (U.S.A.), Sept., 1948, p. 28.

Monitor oscilloscope. Circuit and construction of a built-in monitor oscilloscope for (amateur) radiotelephone transmitter. Uses 2AP1 CRT. Voltages for CRT obtained from a transmitter power supply.—Q.S.T. (U.S.A.), Sept., 1948, p. 49.

Gain measuring test unit. Circuit and construction of a direct-reading db. meter.—Radio News (U.S.A.), Sept., 1948, p. 61.

MISCELLANEOUS:

Screening at V.H.F. Consideration of the efficacy of various metallic surfaces. Description of experimental means of assessing value of each particular type of metal, sprayed-metal, or electro-deposited steel shields.

—Wireless Engineer (Eng.), July, 1948, p. 221.

EDSAC. Electronic delay storage automatic calculator. Details of a machine in course of construction at the University Mathematical Laboratory at Cambridge (Eng.), similar to EDVAC, the American counterpart. Machine is designed as an improvement upon ENIAC.

—Electronic Engineering (Eng.), July, 1948, p. 208.

Surveying with pulsed-light radar. Instrument for surveying in circumstances where usual methods too slow, or which call for long traverses over inaccessible country. Retro-directive reflector placed at point, the position of which is to be determined. Transit time of pulses of light from transmitter and return determines distance. Angles measured by adjustment of optical transmitter so that a maximum return pip is produced on CRT. Claimed that accuracy of method compares favourably with that of third-class survey. Details of circuits and equipment used.

—Electronics (U.S.A.), July, 1948, p. 76.

Photometry. Discussion of fundamentals, and application to television engineering—i.e., performance tests of TV receivers. Provides tables giving units of radiometrical and photometrical terms, as well as other relevant tables, with an explanation of their uses.—Electronics (U.S.A.), July, 1948, p. 110.

Testing photographic shutters. Basic circuits and equipment used in electronic testers. Discussion of growth of application of electronic methods to measurement of shutter speeds and efficiency. Bibliography and list of patents.

—Electronics (U.S.A.), August, 1948, p. 82.

Small selenium rectifiers. Main properties and applications of small rectifiers considered, with details of construction.

—Philips Tech. Review (Holland), Vol. 9, No. 9, p. 267.

Metal-diazonium system for photographic reproduction. Details of a system using solution of diazonium compound and a metal salt, such as mercurious nitrate, for impregnating sheet or strip cellophane. On exposure to light, a mercury image is obtained which is transformed by development into a silver image, and intensified. Claimed that owing to low cost of materials and good results obtained, the system has many applications, such as production of sound-film and for micro- and macro-film documentation.

—Philips Tech. Review (Holland), Vol. 9, No. 10, p. 289.

Electronics in astronomy. Electronic apparatus now in use as: (1) Timekeepers, (2) laboratory aids, and (3) photo-electric photometers. Bibliography.

—Electronics (U.S.A.), August, 1948, p. 98.

Power-level computations. Chart from which, if two quantities are known, two others may be found directly. Relates to voltage, current, resistance, and power (in watts or dbm.).

—Electronics (U.S.A.), August, 1948, p. 122.

Facsimile. Amplitude-modulated low-frequency carriers are used to transmit high-resolution facsimile signals over existing facilities. Describes use of new-type photo-tube in bridge modulator. Light from scanner produces modulation directly, without necessity for generation of frequencies which later must be filtered out.—Electronics (U.S.A.), June, 1948, p. 82.

Radio in the U.S. Merchant Marine. Description, with illustrations, of modern shipboard equipment.

—Electronics (U.S.A.), June, 1948, p. 84.

SOFAR: Sound Fixing and Ranging. A position-determining system designed as a rescue measure for location of castaways at sea or survivors of aircraft wrecked over the sea. Description of the system and its method of operation.

—Electronics (U.S.A.), June, 1948, p. 98.

Oscilloscope camera. Designed for both still and moving film photography of oscilloscope patterns. Speed of camera is electronically controlled—Electronics (U.S.A.), June, 1948, p. 102.

Vibrator power supplies. In view of increased use of vibrator power packs for P.A. and V.H.F. equipment, aspects of vibrator supply design considered, in particular (1) choice of buffer-condenser shunting secondary of transformer, (2) operating conditions of transformer iron and copper with characteristic currents, and (3) suppression of radio interference.

—Wireless World (Eng.), August, 1948, p. 272.

Electronic photo timer. Circuit and construction of simple unit using 100 ma. selenium rectifier and midget-type thyratron. Covers periods from 1 to 60 seconds.

—Radio News (U.S.A.), August, 1948, p. 58.

The patent question. Brief editorial summary of chief differences between U.S. and British Patent Office practice.

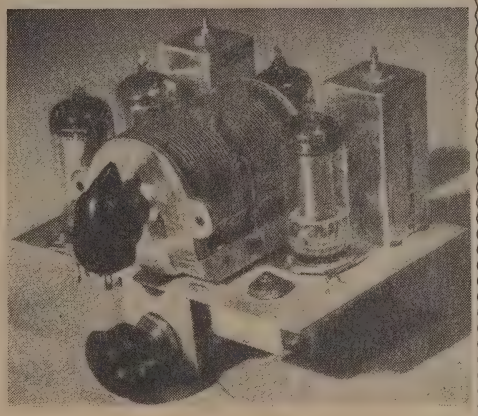
—Wireless Engineer (Eng.), August, 1948, p. 239.

Harbour radar. Details of equipment installed at Liverpool, England.—Wireless World (Eng.), September, 1948, p. 317.

SO SMALL! SO LIGHT! SO POWERFUL!
IT'S ANOTHER "MICROMATIC" QUALITY KIT

Micromatic

◆ "LITTLE PAL" *PERSONAL PORTABLE* ◆



The Ultimate in a Personal Radio—a Midget Set that knows no compromise with quality, performance, or value . . . a Personal Portable Kit with "features."

Fully illustrated next month

ORDER NOW.—Put this kit together and take it with you everywhere: CAMPING, HIKING, BOATING, PICNICS, in the office or around the home.

* * *

Complete Kit, with Cabinet and Batteries **£11 - 10 - 0**

FEAR'S RADIO & CYCLE Co. Ltd. - 31 Willis St. Wellington

FERRANTI
ELECTROSTATIC VOLTMETERS

We have available from ***Stock*** *— Flush-mounting Electrostatic Voltmeters having 2½ inch dial. Diameter front flange 3¼ inches:*

Ranges:

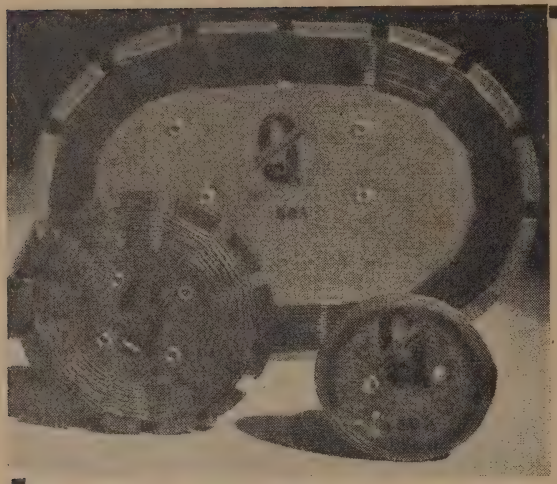
Model A502F	**150–750 Volts**	**Capacitance Full Scale**	**22 μμf.**
Model A504F	**200–1500 Volts**	**„ „ „**	**13 μμf.**
Model A505F	**500–2500 Volts**	**„ „ „**	**9 μμf.**
Model A506F	**1000–3500 Volts**	**„ „ „**	**8 μμf.**

Send your instrument inquiries to:

ARTHUR D. RILEY & CO. LTD.

124 HOBSON STREET, AUCKLAND

66–68 THE TERRACE, WELLINGTON



EFFICIENT Q Inductances HIGH FREQUENCY LOOPS

SPELL...

BETTER PORTABLE PERFORMANCE

- LOOPS: Diamond weave to give maximum "Q" for this size and type of inductor (although more expensive to manufacture, the increased cost is more than warranted by a much greater efficiency).
- LOOPS: Accurately matched and tested to ensure perfect tracking.
- LOOPS: Tropicalized.
- LOOPS: Available in three sizes—
  Type 80A or B, 7½ in. x 5 in.
  Type 150B, 2¼ in. dia. Type 160B, 3½ in. dia.

Obtain the BEST for the HEART of your SET

Inductance Specialists

202 THORNDON QUAY - WELLINGTON

THE NEW "QUILLUX"

PRECISION ENLARGER

at a direct-from-factory price

This high-grade instrument will produce enlargements fully equal to those made by the most expensive equipment obtainable. Furthermore, it has all those convenient features which ensure smooth and speedy operation. Made in Quillars' own factory, and thus sold with one mark-up, it is quite remarkable value. Prices include condensers, 100 watt lamp, negative holder to suit your particular needs, and Sales Tax.

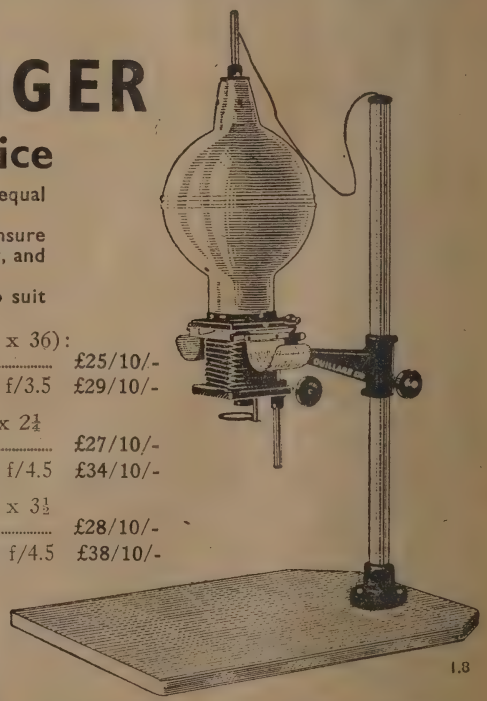
FEATURES INCLUDE optically-worked condensers . . . quick-action focus . . . precision negative holders . . . built-in switch . . . horizontal swing . . . large lamphouse with lamp focusing . . . ruby filter . . . click stops (Dallmeyer lens), handsome appearance.

DALLMEYER CLICKSTOP LENSES supplied at extra cost: Models 1 and 11, £5; Model 111, 50/-; coated, £2 additional, if preferred.

MODEL I, 35mm. (24 x 36):
Without lens £25/10/-
With 2in. coated lens f/3.5 £29/10/-

MODEL II, up to 2¼ x 2¼
Without lens £27/10/-
With 3in. coated lens f/4.5 £34/10/-

MODEL III, up to 3½ x 3½
Without lens £28/10/-
With 4in. coated lens f/4.5 £38/10/-



Obtainable only from the makers

QUILLARS LTD.

42 MERCER STREET, WELLINGTON, N.Z.

I.8

OUR GOSSIP COLUMN

Mr. C. S. Gittoes.

In Wellington for a few days prior to continuing his journey to the United States of America, Mr. C. S. Gittoes, Technical Director of Ducon Condenser Ltd. of Australia, told *Radio and Electronics* that Ducon (N.Z.) Ltd., having passed through the embryo stage of development, was now in a position to supply a full range of electrolytic capacitors. On account of the adjusted exchange rates, a price reduction on previous lists will be made. Mr. Gittoes, who will be away for about ten weeks, expects that as a result of his proposed discussions with several associated companies in the United States there will be a markedly beneficial effect on the further developments of the condenser industry in both Australia and New Zealand.

* * *

Messrs. Ken Stephen and Phil Edwards, both of Messrs. H. W. Clarke Ltd., have returned recently from a trip to Australia. Ken, who is specially interested in "Tecnico" and I.R.C. products, reports that business in radio components over there was booming, and it seemed a good omen for larger receiver output. Phil devoted himself to Westinghouse activity, and the highlight of the trip was a visit, with Ken, to the works of the S.M.A.I.L. factory, probably the largest of its kind in Australia. Here a great production of refrigerators, washing-machines, and ranges was proceeding apace.

* * *

Ron J. Taylor, who for the past three and a half years has been the Wellington Manager for Johnston Cardboard Box Co., Ltd., has been transferred to the Head Office of his firm in Auckland as senior sales executive. Ron, who shared the office suite in Wellington with *Radio and Electronics,* will be missed for his cheery countenance and ready wit. Anyway, Ron, we wish you the best of success in the Queen City, and look forward to seeing you on your periodic visits to the old windy town.

Incidentally, the Johnston Cardboard Box Co., Ltd., is closely associated with the radio industry, as many receivers and components are packed in cartons of its manufacture.

We welcome Jim Blair as the new Wellington Representative of Johnston Cardboard Box, and look forward to a very happy association with him.

* * *

Pres. B. Billing still finds time for his favourite hobby (photography), and during the spring show at Christchurch did the daffodils full justice, as also the tulips in the Wellington Botanical Gardens.

Both Mr. and Mrs. Billing are keen workers for the Wellington Camera Club, Pres. being the President for the current year, and Mrs. Billing acting as Social Convener.

* * *

Seen in Wellington recently was Roy Stevens, Sales Manager, New Zealand Industries, Ltd., Auckland.

TEAM WORK

Mr. Jack Speirs, of Russell Import Co., Ltd., is well known to a considerable cross-section of the New Zealand retail electrical trade as "The Philco Man." To give broader coverage and to include electrical appliances, Mr. Eric Newton has joined the firm, and thus even closer contact will be kept with the retail trade. Ask Eric what cures a headache!

* * *

Congratulations to Ian Hansen, late of Beacon Radio, Ltd. Ian has been awarded a bursary by the British Council which will enable him to be attached to leading manufacturing firms in England for the purpose of becoming familiar with the latest developments in radio and electronics.

Bernard Willis has succeeded to Ian's position in the laboratory of Beacon Radio, Ltd.

* * *

Allan McIntyre, of Wingate & Co., Auckland, has now taken up duty as country traveller for the Hawke's Bay, Taranaki, and Far North districts. Keith Brackenridge, of the same firm, is responsible for the Manawatu and Wairarapa areas, and we were glad to welcome his smiling face when he stopped in at *R. and E.* during his last trip.

* * *

Many readers will be glad to hear that Tas Smith, Managing Director of Wireless Service Co., Hastings, has returned from his trip to England.

CINEVOX CORED SOLDER

Cored Solder is used by the leading commercial manufacturers of radio, engineering, electrical, and telephone equipment. In addition it is approved and used by many Government organizations. Cinevox Cored Solder has satisfied the entire manufacturing field of New Zealand since 1940. It can be purchased from your local dealers in Resin Core, Acid Core, and in the form of solid wires in a number of gauges.

Acid Core in 1 lb. reels only.

Resin Core, in 1 lb. reels, 5 lb. coils and on cards as supplied by leading retailers throughout the Dominion.

Made by Cinevox Limited.

Trade Mark "CINEVOX"

Sole Distributors:

MILES NELSON

P.O. Box 245, Auckland

Trade only supplied.

Philips Social and Sports Club Annual Ball

On 5th October the Philips Social and Sports Club held their Annual Ball for the year in the Majestic Cabaret, Wellington. It was a highly successful evening, the Cabaret being booked to capacity and gaily decorated throughout, congratulations for which are extended to the very active committee.

Our social reporter found time to notice amongst the many guests Mr. and Mrs. N. Swan, Mr. Leighton Lord, Mr. and Mrs. Lusty, Mr. and Mrs. F. H. Griffith, Mr. E. C. and Miss Simpson, Mr. Brian Smith, Mr. and Mrs. R. Slade, Dr. and Mrs. Simmers, etc., etc.

A highlight of the early hours of the morning was the entrance of Mr. Doug. Smith with the joyous news of his achieving parenthood. Congratulations, Doug., keep up the good work.

* * * *

"NEECO" BALL

Thursday night, 16th September, was "Neeco" Ball Night and a merry crowd of employees and their friends foregathered at Wellington's Majestic Cabaret.

Many trade friends of National Electric were present, and everyone seemed to be having a great time.

Among the high-spots of this enjoyable function was the floor show, which featured an exhibition Rhumba and Tango (in appropriate costume) and two solo Spanish dances. The Company's own Joan Ritchie gave a number of songs during the supper interval, charming her audience with an impressive and highly professional performance.

* * *

CLASSIFIED ADVERTISEMENTS

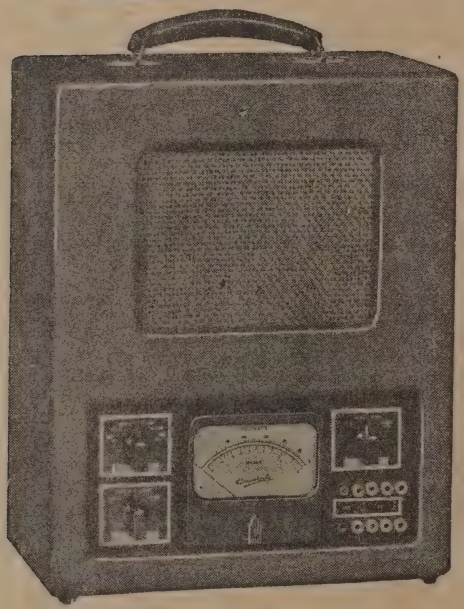
FOR SALE: DA30 amplifier exact to R. & E. circuit, with or without power supply, also Jensen A12 concert speaker with extra field coil, and 15-watt transformer. Hellawell, 21 North St., Palmerston North.

FOR SALE: Whiteley 12" high-fidelity P.M. speaker, in bass reflex baffle, professionally built from *R. and E.* design sheet. Phone 26-942, Wellington.

FOR SALE.—Oscillator Coils for C.R.T. H.T. Supplies. Type 234, 2000v.—Inductance Specialists, 202 Thorndon Quay, Wellington.

University

UNIVERSAL SPEAKER and OUTPUT METER



A new instrument developed and pioneered by Radio Equipment Pty., Ltd. It makes set-testing quick and easy. Incorporates a specially designed loudspeaker which will operate on all receivers. Where field resistances are required, values from 500 ohms to 7,500 ohms are selected by the clearly indicated panel control. Impedance range switch gives you valve matching impedances for single triode, push-pull triode, single penthode, push-pull penthodes. Any speaker socket connections, standard or unusual, are easily taken care of by the quick patching device on the panel.

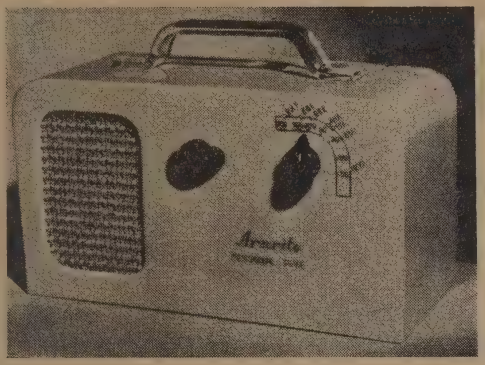
A built-in output meter, with clearly readable scale, is provided and is calibrated directly in decibels and watts. Ranges: 0-500 milliwatts, 0-5 watts, and 0-50 watts. The high-quality University square rectifier type meter is used. It is ideal for use as an output meter in conjunction with any modulated oscillator for set alignment or testing. Centred around a first-grade 8-inch per. mag. speaker, the whole unit will enable most sets to be serviced, even although the speaker belonging to the set may be out of action. All types of receivers, ancient and modern, A.C., battery, vibrator, or A.C.-D.C., can be serviced with this fine instrument. There are no power connections of any description required. You simply plug it into the receiver's loudspeaker socket. Outside measurements, excluding handle: 15½ in. high by 12½ in. wide by 7 in. deep. Weight, approximately 22 lb.

If not available from your regular dealer, write to . . .

ALLUM ELECTRICAL COMPANY LIMITED

AUCKLAND	WELLINGTON	CHRISTCHURCH	DUNEDIN
Pukemiro Buildings,	Nathan's Building,	Somerset House	Marshall Chambers,
Anzac Avenue, C.1	Grey Street, C.1	Hereford St., C.1	399 Moray Place, C.1
P.O. Box 2219	P.O. Box 980	P.O. Box 1193	P.O. Box 384
Telephone 32-160	Telephones	Telephone	Telephone
4 lines	43-590, 46-651	36-736	11-531

Never Before! has there been anything



like the new Sensational

"ARNRITE"

PERSONAL PORTABLE

It has Glamour! It has Pull!
It has Tone! It weighs less than 5 lbs!

Size is only 9" long, 5" high, 4" deep.

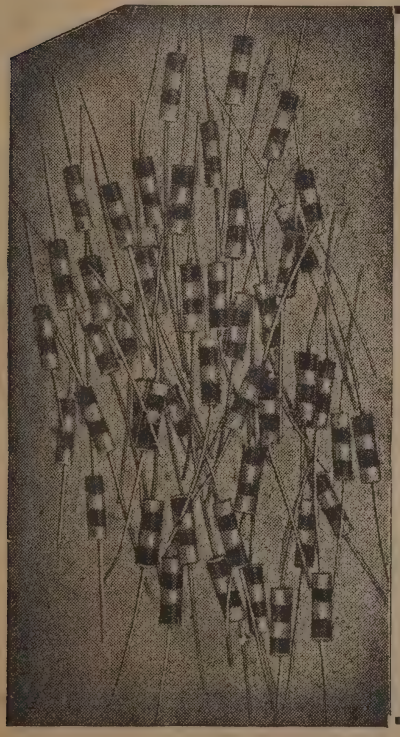
It has all others beaten for Pulling Power, Appearance, and Price.

4 VALVE RETAIL PRICE £18/10/-. 5 VALVE RETAIL PRICE £21/-/-.

Trade inquiries to—

ARNOLD & WRIGHT LIMITED

Head Office: WELLINGTON. Al so at Auckland and Christchurch.



IRC

RESISTORS

Serving the electrical industry for more than 25 years, I.R.C. technicians have evolved Resistors to meet and develop every electrical requirement. When new and unusual types are required, the laboratory is at your service to discuss and produce specified types of any size or rating.

New Zealand Distributors:

H. W. CLARKE LTD.

AUCKLAND, WELLINGTON, CHRISTCHURCH, DUNEDIN

TRADE WINDS

Conference in Mexico City

New Zealand is eagerly awaiting the results of the international conference on high-frequency broadcasting affairs which commenced at Mexico City on 22nd October. The main purpose of this conference is the allocation of frequencies for short-wave transmission throughout the world, New Zealand being particularly concerned with the allocation of future frequencies to "Radio New Zealand."

New Zealand's interests at the conference have been entrusted to the capable hands of Mr. W. L. Harrison, B.E., B.Sc., A.M.I.E.E., Chief Engineer to the Broadcasting Service, and Mr. E. H. Green, M.Sc., M.I.E.E., Chief Engineer to the Post and Telegraph Department.

* * *

Mullard Station Chart

Messrs. C. & A. Odlin Timber & Hardware Co., Ltd., Wellington, have issued a Mullard Station Chart which includes the new frequencies and call signs of many New Zealand and Australian Broadcasting Stations. The Short Wave Chart is also up to date and incorporates the frequencies agreed upon at the International Convention at Atlantic City early this year.

* * *

Sound and Radio Equipment

Sound and Radio Equipment is the title of a 12-page booklet illustrating equipment made by Messrs. Green and Cooper Ltd., of 43 Lower Taranaki Street, Wellington. Copies are available free upon application.

* * *

Faulty Batteries! Torch Cases?

It pays to check the torch case, says Charles Hart, when recently a visitor to National Carbon Works complained that out of four torches he possessed, only one seemed to give long life battery service. C.H. suggested a check-up on the torch cases for faults, which resulted as follows: One torch had an exhausted lamp, one a defective switch, and the third a cracked screw cap which caused an intermittent short.

"Eveready" certainly have all the answers to queries, so don't blame the batteries.

* * *

Gifts

That old perennial "What to give for Christmas" is here again, and for those of you who have young radio enthusiasts we offer a suggestion. Give a year's subscription to *Radio and Electronics*. Just mail your official order and postal note or cheque to us, and we will do the rest, advising the recipient of your gift with any special greeting from you. Act now, while the thought is uppermost. Subscription for one year is 23/- (including postage).

* * *

Tubular Paper and Electrolytic Capacitors

Messrs. Ducon (N.Z.) Ltd. advise that the prices for tubular paper and electrolytic capacitors included on their new price list represent reductions on their previous lists made possible by the reduction in the cost of imported raw materials resulting from the recent alteration in overseas exchange rates.

This company advises that it is now in a position to supply a full range of electrolytic capacitors, including single, dual, triple, and quadruple units in a full range of commonly-used voltages from 6 to 600 peak volts. In addition, the modern bakelite-housed non-polarized motor-start capacitor will be available in the next few weeks.

Paper Capacitors: Initially the production of the Ducon factory was limited to the tubular type of paper capacitor, but now inquiries are invited for all types of paper dielectric capacitors such as metal-cased types for D.C. application, fluorescent lighting, neon lighting, power factor correction, interference suppression, and special types for any application.

Messrs. Ducon (N.Z.) Ltd. advise that their Wellington plant is open to inspection, and they welcome the opportunity of showing those interested something of the intricacies of the manufacture of capacitors. They particularly advise that their specialized test equipment and the services of their technicians are at all times available as a service to assist in problems relevant to capacitor applications. Behind the New Zealand organization are the resources of Ducon Condenser Ltd. of Australia, who to-day are one of the leading capacitor manufacturers in the Southern Hemisphere, employing a staff of 850 people, and who are associated with such overseas organizations as: General Electric Co.; Western Electric Co.; P. R. Mallory Co.; Erie Resistor Corp.; Aerovox Corp.; General Ceramics and Steatite Corp.

Because of this fund of technical information and services available, Messrs. Ducon (N.Z.) Ltd. consider that they can offer you a service in capacitors never before available in this country. Inquiries are invited, and Messrs. Ducon Ltd. assure all of their keen desire to provide real service in the supply of capacitor requirements.

TRAINING FOR TO-DAY'S OPPORTUNITIES IN RADIO

Yesterday's knowledge is not enough to meet to-day's exacting problems and varied opportunities in radio.

Keep step with progress by studying an I.C.S. Course.

For over 56 years the INTERNATIONAL CORRESPONDENCE SCHOOLS have been training men for responsible positions. Many hundreds of radio men throughout New Zealand owe their success to the thorough training which they received from the I.C.S.

COURSES OF INSTRUCTION FOR RADIO SERVICEMEN'S EXAMINATION AND ALL RADIO EXAMINATIONS.

WRITE TO-DAY FOR FREE DESCRIPTIVE BOOKLET

International Correspondence Schools (N.Z.) Ltd.

Dept. E., Wakefield Chambers, 182 Wakefield Street, Wellington

The PHILIPS Experimenter

An Advertisement of Philips Electrical Industries of New Zealand.

No. 13: A PERSONAL PORTABLE U SING THE D90 SERIES OF VALVES

With the summer approaching, it is the time to think of portable receivers, and therefore of the Philips D90 series of valves. These are very similar in characteristics to American type 1.4 volt miniatures, and use the same sockets. In many cases the D90 valves are able to replace American counterparts exactly, both with regard to characteristics and to base connections. The DF91 is a

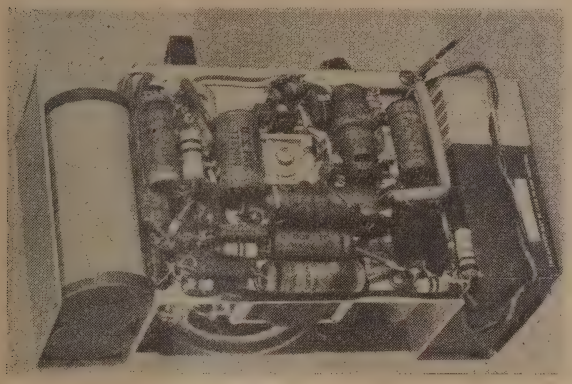


Fig. 1.

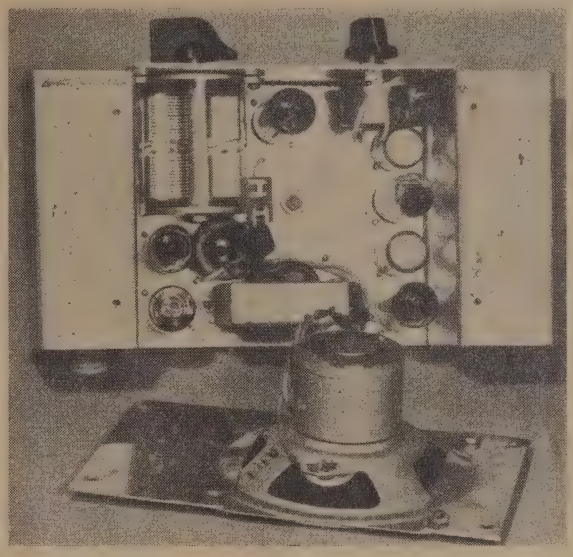


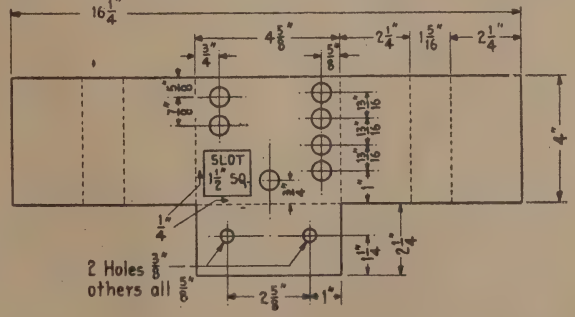
Fig. 2.

variable-mu pentode for use in the R.F. and I.F. stages, the DK91 is a pentagrid converter, the DAF91 is a diode pentode for application as second detector, A.V.C. rectifier and audio voltage amplifier simultaneously, and finally the DL92 is an output pentode. The first four have 1.4v. filaments, drawing 50 ma. from the "A" battery, while the DL92 has three filament pins, enabling the two halves of the filament to be used in parallel, with 1.4v. at 0.1 amp., or in series, drawing 50 ma. at 3 volts.

General Description

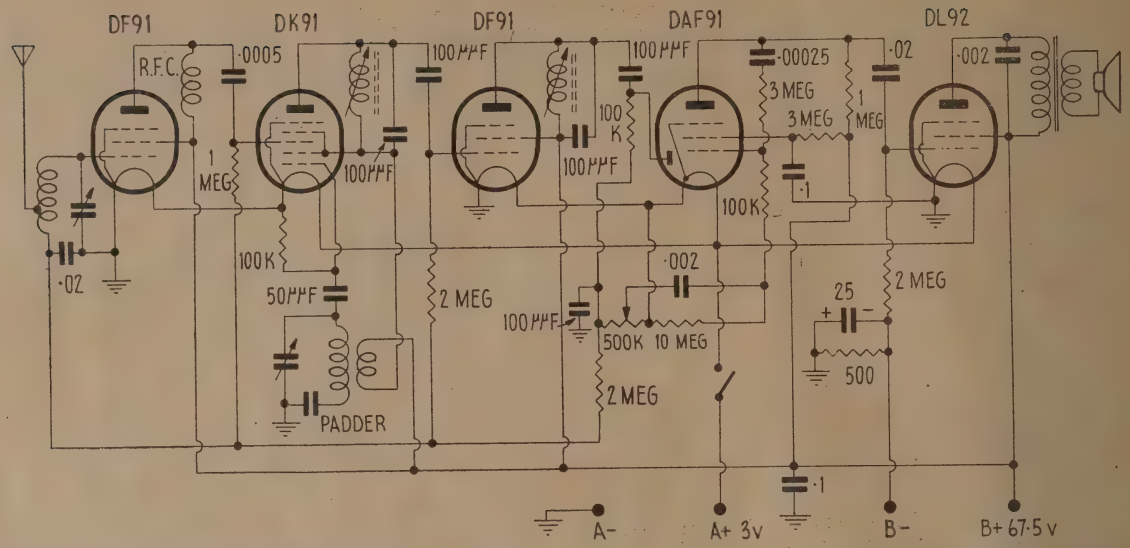
In describing this set as a personal portable, we are referring to its small size, and its general design, which is such as to make it very suitable for carrying by means of a shoulder strap. The set does not include a loop aerial, but has been designed to operate from a wire threaded through the carrying strap, after the manner of a number of portable sets that have been illustrated in the overseas literature.

With this idea in view, and so that the design given in these pages will not tie anyone down to a set cabinet design, the chassis has been arranged so as to hold the batteries as well as to support the valves, speaker, and wiring. The accompanying diagram and photographs show how this has been done. The chassis is made from a single piece of steel or aluminium, preferably the latter, on account of lightness. The centre section, which can be recognized on the diagram by the mounting holes, measures 4" x 4⅜". There is a small panel which is bent downwards to take the controls, and on which the gang condenser and volume control potentiometer are mounted. The two bands shown at the left and right-hand edges of the centre section are also bent downwards, so that the whole forms a rectangular box with one side missing. The remaining material is then bent back in re-entrant fashion to form two U-shaped channels, one on each side of the chassis proper. These channels hold the "A" and "B" batteries, one on each side. A glance at the two photographs will clarify this description. Fig. 1 shows the top of the chassis, with the small parts mounted on it, and the batteries in their U-shaped holders. In this photograph the valves cannot be seen, as they are upside down. At the back of Fig. 1 a glimpse is obtained of the pointer knobs of the controls. At the left is the one belonging to the volume



control, and the right-hand one belongs to the gang condenser, mounted under the square cut-out, which allows the connections and trimmers to be got at.

Fig. 2 shows the underneath of the chassis, and the way in which the loud-speaker is mounted. The valves



can be seen in this photo, as can the output transformer, the volume control, the midget I.F. coils, and the R.F. choke which is connected in the plate circuit of the R.F. amplifier. In this picture, the valves are as follows. Next to the gang condenser, between it and the volume control, is the oscillator-mixer. Directly in front of the gang is the R.F. stage, and alongside this can be seen the R.F. choke. In front of the volume control is the first I.F. coil, and in a line towards the front of the photograph are the I.F. amplifier, the second I.F. coil, and the DAF91 detector and audio valve. The remaining valve, on the opposite side of the output transformer, is the output valve. Now, referring to the chassis diagram, the circular mounting holes run as follows. At the back left-hand corner is the output valve. In front of it is the R.F. valve. The hole nearest the square cut-out, at the front, is the DK91, while the four holes at the right-hand side, from front to back, are: first I.F. coil, I.F. amplifier, second I.F. coil, and DAF91 respectively. The free space visible under the chassis in Fig. 2 is where the speaker pot. goes. In this photo, the speaker mounting holes can be seen, two in the bottom of each battery compartment. It will be noticed that the speaker is screwed to two flat plates, which themselves bolt on to the chassis through the four holes referred to. It was not possible to mount the speaker in the centre of the chassis without increasing its size, so that the unsymmetrical arrangement has to be put up with. This does not mean that the cabinet need be designed with the speaker grille off-centre, since the grille can be made rectangular, as is often done, with the speaker actually at one end of it.

The Circuit

The circuit used is for the most part conventional. In the interests of conserving space, the coupling between the R.F. stage and the mixer is untuned, as this enables a two-gang condenser to be used. A certain amount of sensitivity is thereby sacrificed, but when small size is a main consideration, sensitivity is not so important as usual.

Perhaps the main point of difference between this and other portable circuits is the use of a series-parallel filament arrangement. This does not have any particular virtue as far as performance is concerned, except for one thing. It enables a 3-volt cycle battery to be used for the "A" supply. This is really quite an important feature, as this type of battery has a greater capacity than could be obtained if a number of smaller 1.5-volt cells were used in parallel. It also has an important bearing on the mechanical design, since there is no "A" battery of 1.5 volts which approximates in dimensions the Minimax 67.5v. "B" battery that it was desired to use for the sake of its small size. As luck would have it, the 3-volt cycle battery, No. 701, is almost identical in dimensions with the 67.5-volt Minimax No. 467. The battery compartments were thus made of the same size. Also, the negative terminal of the No. 701 makes a spring contact with the side of the chassis, making a special connector unnecessary. The DL92 is used in its series-filament connection, while the other four valves are grouped with the R.F. stage and oscillator-mixer in series, and the I.F. stage filament in series with that of the DAF91. This connection did not have any effect on the operation of the set, as revealed by a check made by re-wiring the filaments to parallel operation.

Another feature of the circuit is the use of midget I.F. coils manufactured by the Swan Electric Co., Ltd. These are exceedingly minute, and mount in sockets requiring the same sized hole as the miniature valves. Their use increases the gain of the I.F. amplifier, compared with a stage which uses miniature double-wound transformers. A.V.C. is applied to all three of the R.F., mixer, and I.F. valves.

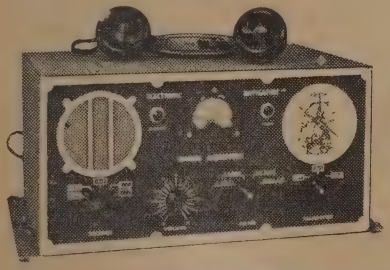
There is an innovation in the audio amplifier circuit that is worth mentioning also. It is the negative feedback applied to the voltage amplifier, the pentode section of the DAF91. This connection consists of a 0.00025 μf. condenser in series with 3 megohms, applied between plate and grid of the DAF91. When the volume control potentiometer is at minimum, the amount of feedback is very small, being determined by the voltage divider formed by the feedback resistor and the 100k. grid stopper in series. As the volume control is advanced, the degree of feedback increases. This behaviour adds to the effectiveness of the A.V.C., and has the further advantage that even at the maximum setting of the volume control, on a strong local station, the output valve is not overloaded. At the same time, it is possible to realize the maximum output of which the DL92 is capable.

Navigation and Communication Equipment—Marine—Mobile

Costs, Installation, Data, on request

"Radiophone" 12-watt on 30-watt (aerial power). Three transmitting and receiving spot frequencies, 1.5 m/c.–3 m/c.; 12 or 24-volt input.

Marine Radio Telephone and Wireless Telegraphy Station: Three R/T channels, med. frequency W/T M.O. 70 watts aerial power; 24-volt input. Receiver listens out on three channels simultaneously.



ELECTRONIC NAVIGATION Ltd.

NAGEL HOUSE, COURTHOUSE LANE, AUCKLAND

Code: "Radar" Telephone 40-576

NEW 'ARIEL' BATTERY-AC Midget Portable

★ *ALL-PLASTIC CASE* ★

Specially designed as a very small personal radio operating either from built-in batteries or 230-volt A.C. mains. Compact, attractive in appearance, and combines good volume and tone with maximum sensitivity for weak stations. It measures only 9″ x 6″ x 3¾″ and is a wonderful asset for picnickers, campers, yachtsmen, etc. Simply by turning a switch it can be converted into the ideal "spare" home radio for bedside or kitchenette. The case is highly polished moulded sheet plastic, shaped for easy carrying, and available in a selection of colours. Special designing of the tuning and volume controls eliminates the usual unsightly projecting knobs, tuning, etc., being done by drum-type drives recessed into the case. The neat carrying handle will flatten against the case when not in use. Two ordinary standard torch cells provide "A" battery power, and a 67½-volt "Minimax" is used for the "B." Batteries are easily accessible by removing the two screws holding the back half of the case in place. Five peanut-size tubes, aperiodic tuned R.F. stage, high-gain iron-cored midget I.F. transformers, and selenium power rectifier are features of the circuit, and although extremely small in size the set incorporates a sensitive 3½″ speaker to give ample power output. A built-in tuned loop antenna and detachable power flex make the set completely self contained.

Inquiries invited for prices of cabinet, chassis, etc.

WEBB'S RADIO LIMITED

11 WELLESLEY STREET EAST, AUCKLAND

ADDING AN S-METER

(Continued from page 7.)

once, and will thereafter never need touching. Should the bridge drift out of balance after a period, the zero can be re-set using R_3. It should be pointed out that the zero should always be set with the aerial short-circuited; any reading that occurs after the aerial has been re-attached is then a measure of the noise coming in through the aerial and other sources. If the zero-setting is done with the aerial on, frequent re-setting will be necessary, on account of the variation in noise-level from time to time.

Circuit for Sets with which the Previous One is Unsuitable

The above scheme, while adaptable to the great majority of receivers, will not suit all of them. One example of this is the set in which regeneration is applied to one or more of the stages that are controlled by A.V.C. The circuit would still act as a tuning indicator, but on account of the regeneration controls it would not indicate relative signal strengths at all. The circuit of Fig. 3 overcomes the difficulty, although in the case of the regenerative set, it would be necessary to use it without regeneration, or else at standard settings

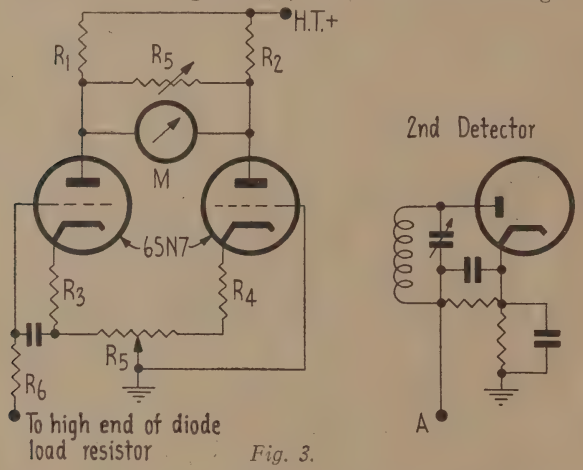


Fig. 3.

of the controls if readings are to be interpreted as indications of signal strength. The circuit of Fig. 3 is also applicable to any set in which the different biasing arrangements for the controlled valves make the previous circuit impracticable.

In Fig. 3 we have a separate valve to operate the meter, and this is nothing more than a D.C. vacuum-tube voltmeter, measuring the D.C. output voltage of the detector diode. Its installation is a very simple matter, and with the values shown will give no difficulty. The values shown are for the case where the cathode of the detector diode is earthed. If, as in Fig. 4 the detector diode's cathode is above ground, there will be a small positive bias on the left-hand section of the valve, and this will have to be counteracted by making R_3 considerably larger than R_4. Practically, the circuit can be adjusted in this case by removing M and R_5, and substituting the multimeter, set to one of its voltage ranges. Then there will be no possibility of damaging it if the circuit is well out of balance. Various values of R_3 are then tried until one is found which allows exact balance to be made within the range of R_5. After this, the multimeter can be removed, and the meter and its shunt put back in circuit. The shunt in this circuit serves the same purpose as the series resistor in Fig. 1, namely, to limit the deflection to a safe degree when the strongest signal is being received. There is no need with this circuit to take into account what happens when the manual volume control is operated, because it can have no effect on the meter circuit, which here is a true output voltage meter. The meter for this circuit should preferably be a 0-1 ma. movement, although a 0-2.5 or 0-5 ma. movement might be sensitive enough. R_5 is simply adjusted with the largest signal being received, until the meter reads full-scale.

No attempt has been made in this article to describe all the possible arrangements, but we have merely attempted to give circuits that will be applicable to the greatest possible number of receivers. There will be very few sets that do not suit one or the other of these two circuits, the main ones being those which do not have a diode detector or an A.V.C. diode. If this is the case, it would be a simple matter to install the circuit of Fig. 4, with the further addition of a diode detector from which to work it.

PHILIPS EXPERIMENTER

(Continued from page 42.)

The aerial coil used was an Inductance Specialists' type 140B, removed from its can and mounted on top of the chassis on a small aluminium bracket. It can be seen in Fig. 1 with the former parallel to the front of the chassis, and about in the middle of the photograph. The oscillator coil, the same manufacturers' type 51BY, can be seen mounted directly over the cut-out for the gang condenser by means of its connecting lugs. Although there is not a great deal of room on the chassis, it is possible to get everything in, and in the prototype the small parts did not come more than $\frac{3}{4}$" higher than the top of the chassis. The inside size of the cabinet necessary is therefore $7\frac{1}{2}$" x $3\frac{1}{4}$" x 4". This does not include the knobs, since these come outside the cabinet in any case.

TELEVISION NOT SCOOPING THE POOL

In spite of the fact that television and F.M. receivers are selling in the U.S.A. as never before, and regardless of the ever-increasing coverage of these two new services, the sales manager for one of America's largest manufacturers of television (and ordinary radio) receivers stated recently that there was still an enormous potential market in the States for broadcast and all-wave receivers of the standard types. R.C.A., this spokesman said, is now selling more standard radio sets than ever before, so that the gloomy prophets who predicted that television and F.M. would flourish only at the expense of ordinary radio business are proved to have been wrong.

In New Zealand, radio retailers seem to have a firm conviction that the mere possibility of television—which is not even a remote probability here as yet—is reducing the market for standard radio sets. This can hardly be true in the light of the above authentic information from the U.S.A. There, as here, the possibilities for the radio industry that abound in the "Radio in Every Room" campaign have hardly been touched. While it is certainly true that television, when finally it does come to New Zealand, will create much new business, it seems to us that a vigorous sales campaign is all that is needed to reveal the true extent of our latent radio set market.

NEW PRODUCTS: LATEST RELEASES IN ELECTRONIC EQUIPMENT

An announcement appears in the advertising section of this issue regarding new "Avo" British-made measuring instruments especially developed for the radio serviceman. Abridged details of these instruments are as follows:

"Avo" High Sensitivity Multimeter

This instrument is comparable in dimensions with the standard "AVOMETER" but is characterized by a sensitivity of 20,000 ohms per volt on D.C. and 1,000 ohms per volt on A.C. The following ranges are provided:

RANGES

D.C. current	*D.C. volts*	*A.C. volts*	*Resistance*	
50 μA	2.5	10	0 to 50—first indication	0-1 ohms
250 μA	10	25	0 to 50,000 „ „	10 ohms
1 mA	25	100	0 to 5 meg. „ „	1000 ohms
2.5 mA	100	250		
10 mA	250	1000	All with internal battery.	
25 mA	1000	2500		
100 mA	2500			
250 mA				
1000 mA				

"Avo" Electronic Test Meter

The "Avo" Electronic Test Meter is an instrument which presents a negligible load factor upon the circuit under test, and whilst capable of making a wide series of measurements with laboratory accuracy, it has robustness, stability and ease of handling of an ordinary multirange meter. It is a 49-range measuring instrument of extreme versatility and high accuracy. It consists basically of a highly stable D.C. Valve Millivoltmeter substantially independent of mains voltage fluctuations, with subsidiary circuit switching to provide the ranges enumerated below. The use of a thermionic millivoltmeter circuit endows the instrument with a sensitivity associated with a delicate galvanometer, at the same time using a robust moving-coil movement. It is almost impossible to damage the movement by overload.

RANGES:

D.C. Volts: 2.5 mV. to 10,000v.
D.C. Current: 0.25 μA to 1 amp.
A.C. Volts: 0.1v. to 2500v. R.M.S. up to 1.5 mc/s. With external diode probe 0.1v. to 250v. R.M.S. up to 200 mc/s.
A.C. Output Power: 5 mW. to 5 watts.
Decibels: — db. to + 20 db.
Capacitance: 0.0001 μf. to 50 μf.
Resistance: 0.2 ohms to 10 megohms.
Insulation: 0.1 megohm to 1000 megohms.

"Avo" Wide Range Signal Generator

This is an inexpensive mains-operated R.F. Generator of remarkably wide range and accuracy of performance. Six ranges cover fundamental frequencies of 50 kc/sec.-75 mc/sec., turret coil switching being employed. A modified colpitts oscillator employing an H.F. pentode with amplitude limiting circuits gives a pure waveform and remarkably constant high level signal into the attenuator over the full frequency range.

A simple yet efficient calibrated slide wire attenuator is fitted, together with a non-reactive four-decade multiplier, giving a calibrated output from 1 μV. up to 50 mV. at an output impedance of 80 ohms into a matched concentric cable terminating in a screened all-wave dummy aerial.

The R.F. signal can be modulated to a depth of 30% by a 400 c/sec. signal of good waveform and this L.F. signal is available via a variable potentiometer at external sockets for test purposes. Provision is also made for external modulation and a pure R.F. signal.

"Avo" Valve Characteristic Meter

This is a most comprehensive Valve Tester built into one compact and convenient case, which will test any standard British, American, or Continental receiving or small power transmitting valve on any of its normal characteristics, and under conditions corresponding precisely to any desired set of D.C. electrode voltages. A patented method enables A.C. voltages of suitable magnitude to be used throughout the Tester, thus eliminating the inherent regulation troubles and inaccuracies associated with D.C. testing methods. It is of the mutual conductance type and in addition to the standard tests of interelectrode insulation and heater continuity, it can be used to obtain complete information on the performance of a valve. A few of the major tests that can be carried out are: anode current and screen current characteristics, amplification factor and anode A.C. resistance, and mutual conductance on any desired electrode voltages. Rectifiers, diodes, and diode sections of multiple valves can be tested under load conditions.

Further information on any of the above instruments can be obtained from the sole New Zealand Distributors, the National Electrical & Engineering Co., Ltd. Branches at Auckland, Wellington, Christchurch, Dunedin, Wanganui, Hastings, and Hamilton.

INTER-ISLAND CARGO TRANSPORT

Economical RAIL-AIR Daily Service

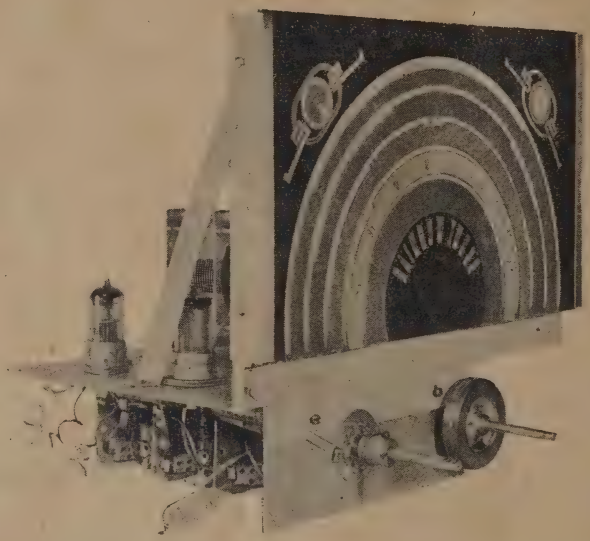
Every railway station is a depot, to and from which freight may be consigned for inter-Island transport by air. Usual railage, plus low air-rate, makes RAIL-AIR the most economical means of Island-to-Island transport for parcels and freight. Senders of parcels and goods in large or small lots, save time and money by using RAIL-AIR.

●

Full Particulars from any Stationmaster or Railway Goods Agent.

S.O.S. RAINBOW TUNER

ITS HERE! ITS NEW! ITS WIZARD!



- Attractive rainbow dial with seven colours. 12″ x 6½″.
- New Rimlock Tubes, EF41 R.F., ECH41 mixer.
- EM34 eye operates on all stations.
- Five bands covering B.C. and 16m. to 80m.
- Silver ceramic trimmers on oscillator section.
- Special Perspex dial pointer eliminates parallax error.
- Completely aligned and tested.
- 80-metre spread 9″ long, 3.5 to 4.

The S.O.S. Rainbow Tuner is the successor to the famous S.O.S. De Luxe Bandspread Tuning Unit. It incorporates many new features and is a first-class tuning unit. Write for further details.

Price of Tuner, including EF41 and ECH41 valves, but less EM34 eye valve .... £14 - 15 - 0

Cadmium plated Chassis for 7 valve 15/-

S.O.S. RADIO LIMITED

283 QUEEN STRET, AUCKLAD, C.1

BEGINNERS' COURSE

(Continued from page 10.)

as to make the cathode somewhat positive with respect to earth. The grid, however, is at earth potential, because it is connected directly to earth through the grid resistor. Since no direct current flows through this resistor, the grid must be at the same potential as the chassis of the set. Thus, we have the cathode at a *positive potential with respect to the grid.* This is the same thing, as far as the valve is concerned, as if the cathode were earthed and the grid had a negative potential placed upon it. The grid bias in a case like this is equal to the voltage drop across the cathode resistor, and within limits, any desired bias can be provided simply by altering the value of the cathode resistor. The higher the value of this resistor, the higher will the bias voltage be.

It is by no means impossible to use the same scheme for biasing a filament type tube, but this is very rarely done. The reason is not far to seek when we examine Fig. 36 (b). Here, we have a resistor connected between one side of the filament and earth, and this resistor is bypassed by a condenser just as in Fig. 36 (a). The same line of reasoning as before shows that the resistor connected between earth and the filament places the latter as a positive potential with respect to earth when plate current is flowing. The grid is therefore biased negatively, as is required. The awkward thing about this second circuit is that the "A" battery cannot be connected to earth. If "A" were so connected, the bias resistor would be short-circuited and no bias would result. If this circuit is to be used with a battery valve, either it must be the only valve, or else it must have its own filament battery, which must be entirely separate from the other valves in the set. This in turn introduces complications, in that two filament switches would have to be used to turn the set on and off, and so on. Thus with battery valves one gains nothing in convenience by trying to use this form of bias, and instead, runs into difficulties. For this reason battery bias is much to be preferred for battery valves.

Next month, we will delve further into audio amplification, but this time from the practical point of view, and show how more than one stage of audio amplification can be used, and that if this is done, it is possible to operate a loud-speaker instead of headphones.

(To be continued.)

SPECIALISTS IN A
SPECIALIZED FIELD.
BY TEST
THE BEST
Inductance Specialists
THE N.Z. HIGH FREQUENCY SPECIALISTS
202 THORNDON QUAY, WELLINGTON, N.Z.
COILS, I.F. TRANSFORMERS, H.F. CHOKES, B.F.O.'s DIALS, SCALES, COIL ASSEMBLIES, GANGS, BUILT-UP UNITS, ETC.

RADIO DIAL SCALES

Employing a new method, Rotoscreen Studios are now producing dial scales unexcelled in appearance and price. Whether your requirement is for 100 or 2,000 scales, the Rotoscreen process is the most satisfactory and economical means of obtaining a high-quality article. The special lacquers used give an "edge lighting" or "flood lighting" effect which compares more than favourably with any other type of scale. In addition, the process is particularly suitable for celluloid, which enables attractive roll or drum-type dials to be easily incorporated in radio receivers.

For further information, write to

ROTOSCREEN LIMITED

BOWEN HOUSE, BOWEN ST., WELLINGTON

Telephone 44-386. Also Lower Hutt 395/905s

RADIO TRAINING

NEW COURSES

New Courses at Day Classes or Evening Classes for Radio Telegraph Operators and Radio Technicians

Commence 31st January 1949

●

Expert instruction on modern commercial equipment. Positions assured on qualifying. Make early application for Prospectus.

●

N.Z. RADIO COLLEGE

24-26 Hellaby's Building (opp. C.P.O.)
AUCKLAND, C.1

THE RADEL SINGLE-TWIN

(Continued from page 16.)

in the 'phones, the positive B lead is momentarily touched on to the terminal. If all is well, a fairly loud click should be heard in the 'phones as this is done, and nothing else should happen. The B + lead can now be permanently attached to its terminal.

The set is now ready to go, if instructions have been properly followed. The aerial is attached to the aerial terminal, and the alligator clip is taken to the topmost aerial coil connection, so that the whole aerial coil is in use. The reaction condenser, C_2, is turned fully anti-clockwise (i.e., leaves unmeshed) and the tuning condenser C_1 is turned slowly. By now, if there is a strong local station, it will be heard, and can be tuned in at maximum volume. If there are more than one strong local stations, it is quite possible that two of them will be heard at once, both quite strongly, but this need not cause any concern. The reception of these stations shows that the set is working, at least in part. The next step is to disconnect the aerial and make sure that the reaction control works properly. The tuning dial is set about in the middle of its range, and the reaction control is turned very slowly clockwise. When it is about half meshed, there should be heard a gentle rushing noise, which can be removed again by backing off the reaction condenser slightly. If the condenser is moved too quickly, one may miss the onset of the rushing sound. The place on the control where it starts is very important, as when the rushing has just not started, the set is in its most sensitive condition, and can then pick up very weak distant stations. Now shift the tuning dial a little, and manipulate the reaction control again until the rushing noise is heard. It will be found that this time a different setting of the reaction control is needed to give the noise. Once this has been recognized, and one is used to finding the sensitive condition in the way we have described, the aerial can be re-attached, and the business of tuning in a more distant station tried. First of all, take a spot on the dial as far from the strong local stations as possible, and attach the aerial alligator clip to one of the lower tappings of the aerial coil. It will be noted now that when the set is brought to its sensitive condition with the reaction control, the local stations can be heard only weakly, if at all, whereas before, with no reaction, and with the whole aerial coil in use, these spread out over most of the dial. The purpose of the aerial taps is to make the set more selective, in this way, so that distant stations can be received even when the local ones are on the air. Also, the set is not only most sensitive when the rushing noise is about to begin, but is also in its most selective state. In order to search for a weak station, the reaction control is set so that the rushing noise has *just started*. This means that the set is now *oscillating*, and that if it is tuned across a weak signal, a quite loud whistle is heard. Using both hands on the controls, one for tuning, and the other to keep the set just oscillating and no more, the dial is traversed until a whistle is heard. Now, the reaction control is left set for a moment while the tuning is adjusted. The dial is set so that the pitch of the whistle is as low as it will go, and then left set. Then we return to the reaction control, and back this off very slowly, until the whistle stops. When this happens, the weak station will be heard quite clearly, and all that is needed is perhaps a *very slight* and very careful re-adjustment of the tuning control, to get the best results. A very little practice will enable the user to tune in weak stations quite easily, although the process sounds quite complex when described on paper.

Before we leave the operation of the set, it should be made clear that the aerial tapping points are to enable extra selectivity to be obtained *when necessary*, which is only when a local station is interfering with the one it is desired to tune in. In country districts, it will hardly be necessary to use the aerial taps at all. The stronger the local stations are, the more selectivity will be needed, and this is why a number of taps have been used. The rule to observe is this: that the aerial should be tapped down the coil only as far as is needed to reduce the local-station interference. This is because when only a few turns of the aerial coil are in use the set is noticeably less sensitive than when the whole coil is employed. If this rule is remembered, there should be no difficulty in receiving Australian broadcast stations at night, in almost any locality, even when the locals are on the air.

ERSIN

MULTICORE SOLDER

"The finest cored solder in the world."

Containing 3 cores of non-corrosive Ersin flux.

THE 7 lb. REEL

Ideal for the Radio Serviceman . . . saves time and increases efficiency.

13 S.W.G. 45/55% tin/lead alloy high-quality radio solder. List price 9/4 per pound — usual trade discounts.

Free Samples gladly supplied on request.

N.Z. Distributors:

GILES & ELLIOTT LTD.

9–11 BLAIR ST., WELLINGTON

Telephone: 54-695 Telegrams: "RADOGEN"

Amateurs—Experimenters—Home-Builders—

For Your Book Requirements

CONSULT—

Te Aro Book Depot Ltd.

Gas Coy's Building,

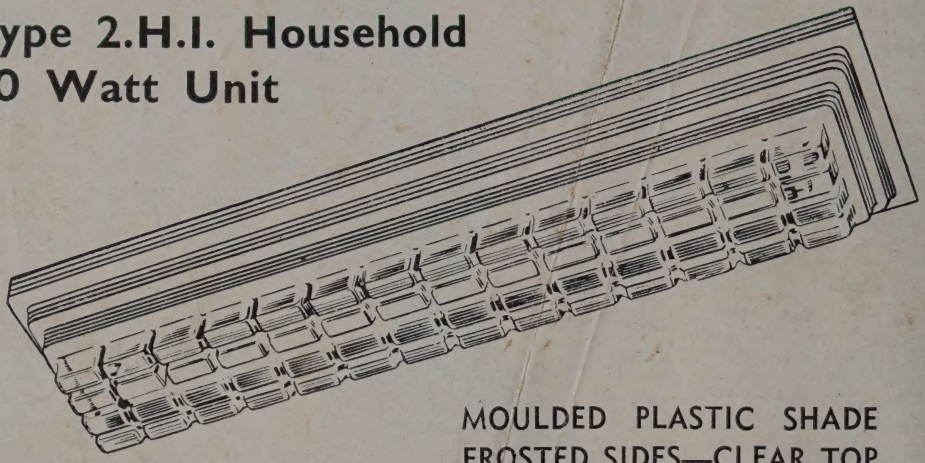
64 Courtenay Place :: Wellington

It's like this...

. . . STRICTLY SPEAKING, I HAVE NO BUSINESS TO BE IN THIS ADVERTISEMENT, BUT, AS A LADY THAT'S NOT EASILY FORGOTTEN, I THOUGHT I WOULD ACT AS AN IDEAL REMINDER THAT THE CHRISTMAS AND HOLIDAY SEASON IS FAST APPROACHING. OF COURSE, AS YOU KNOW, THAT MEANS A FRIGHTFULLY HECTIC DEMAND FOR RADIO AND FLASHLIGHT BATTERIES . . . SO BE SURE THAT YOU ARE AMPLY STOCKED WITH ALL TYPES OF "EVEREADY" FLASHLIGHT AND "EVEREADY" MINIMAX RADIO BATTERIES.

Improved Trouble-Free
FLUORESCENT LIGHTING

Type 2.H.I. Household
20 Watt Unit



MOULDED PLASTIC SHADE
FROSTED SIDES—CLEAR TOP
LENGTH 2′ 9″ — WIDTH 6¾″ — DEPTH 4¼″

- Minimum Flickering Starters
- Quick Start
- Quiet as a Kitten
- Simplified Circuit
- Smarter and Stronger Fittings

WESTCO IMPROVED FIXTURES

The improved ballast and quick, reliable starters make these the logical and Fastest Sellers.

HIGH LIGHT AT LOW COST

GET YOUR SHARE OF THE PROFIT. Our engineers have designed and constructed a complete line of domestic and industrial FLUORESCENT Lightings and Fittings.

TO DEALERS ONLY

Order from our wholesale distributors or write direct.

- Maximum Lighting Efficiency
- Sturdy Construction
- Trouble-free
- Easy to Install
- Ventilated Bodies

★ WESTCO product ★

● THE LABEL THAT MEANS A JOB WELL DONE!

Address your inquiry to

WESTONHOUSE RADIO Ltd.

Manufacturers of Radio and Electronic Equipment — General Metal Workers. 12–14 Kitchener St., Auckland. Phones: 42-577, 49-012. Box 8, Wellesley St. Cable and Telegraphic Address: "WESTRAD," Auckland, N.Z.